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Sustainable development – an idea for our time

- Hormones and menopause
- The future of relationships
- Sydney's green Olympics
 The ghostly neutrino
 - Australia's superchip

Supporting education

Telecom Australia is supporting the Australian Commission for the Future in sponsoring **21C** in to secondary schools throughout Australia. This issue of **21C** will be delivered free to secondary schools in South Australia and Tasmania. Past issues have gone to secondary schools in New South Wales and Victoria. Like the Commission, Telecom Australia recognises the need for ongoing promotion of greater awareness about science and technology among children if we are to fulfil our future as a 'clever country'.

Telecom Australia is also committed to creating a sustainable future for Australia. For instance, Telecom is a major sponsor of Landcare Australia.





MESSAGE FROM HON JOHN BESWICK, MHA, MINSTER FOR EDUCATION AND THE ARTS, TASMANIA

Planning for preferred futures is a goal which we can aspire to with optimism and a sense of active purpose. The Australian Commission for the Future, through its magazine **21C**, has long provided stimulus for us all to view the future as something which we can in part create for ourselves.

Today's students will face a very different world just twenty years from now. It is important that the education they receive helps prepare them for an active and constructive role in 21st century society.

21C is a resource which will help provide a perspective for the future and I am pleased to be involved in making this copy available to all schools in Tasmania.



MESSAGE FROM
HON SUSAN LENEHAN,
MINSTER OF EDUCATION
EMPLOYMENT AND
TRAINING,
SOUTH AUSTRALIA.

21C is food for thought.

It is a nourishing diet of information on education, technology, popular culture, science, arts and environment to name just a few of the topics being explored. The breadth and depth of the topics covered should satisfy the perceptive reader's appetite.

Take a user friendly writing style, put it in an attractive layout, add the main ingredients — thought provoking articles on a good variety of topics – and sprinkle a little vision on top, and you have the perfect recipe for a magazine to suit the most discerning tastes.

This formula can also be a creative recipe for education. Education is a life-long process requiring careful mixing of ingredients in order to produce quality opportunities for young people to develop to their full potential.

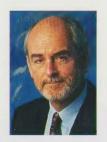
21C is a rich resource which should appeal to students of all ages.

John Jost

n the spring issue of 21C we began to implement our policy of using experts to do the writing about new ideas in their fields rather than journalists. In the case of 21C, you might recall, I said in this column that we wanted

journalists to work as editors while people actually working in science, technology, and industry would write about their fields, and the new ideas emerging from them. Well, some of my journalist colleagues were surprised by this policy and argued that trained writers make the best writers. Ordinarily I would agree, but the proof of the pudding is in the eating. Our spring issue had a tremendous impact and received wide media coverage - something like 50 radio stations around Australia interviewed 21C authors about their stories. Further, there were numerous printed reports about issues raised in the magazine. It all serves to confirm that the policy is the correct policy: this country needs a magazine that directly introduces the experts to those members of the public who want to hear from them.

has many professional and learned journals, be they scientific, medical, legal, technical or economic, but they only reach the discipline they report. 21¢ aims to bring together the best or most accessible work of experts from all fields, so that all experts or any other interested people can catch a glimpse of the work involving new ideas and innovations occuring in this country. So much new work is being done in many fields in Australia, there is a need for a good magazine as a window so we can all view what's happening. CP Snow wrote about the twin



cultures, the worlds of scientists and the non-scientists, predicting that a huge communication gap would grow between both. Snow was right and wrong. In a sense, he actually underestimated the differences. In this world of

specialisation it is quite likely that some of our best brains might not know what the other clever brains are up to...

hich brings me to the subject of 'brains'. We are on the look-out for experts or researchers who want to write about their work. We take a broad view - no discipline or field is outside the interest of 21C. We can offer such people the very best of editing and assistance so that their work can be understood by non-experts, albeit intelligent nonexperts. I invite anyone who wants to publish to make contact with the editor, Don Hewett. There is no guarantee you will be published, but you will get a good hearing. If eventually you do get published, the quality of the editing, as I have said, will be as high as the sustainable development feature (written by hands-on experts) in this summer edition. The same invitation is extended to photographers, artists and graphic artists. We want to make contact with the best.

n apology. I promised an information technology special for this issue but it has grown bigger and better than we thought. The IT special will be published in the Autumn issue, and will deal with the impact of new technology at work – and in the place where we all the live, the home. Until then, good reading, seasons greetings, and all the best for 1994.

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21C

Reading for the new year ...about the new century

At \$40 for five issues 21C represents tremendous value for readers concerned about the world around us and the future we face. 21C is Australia's only magazine devoted to publishing the ideas and endeavors of those who are working at the leading edge in their chosen fields. It is an indispensable aid for people who want to know what's really important.

Look for the subscription brochure inserted in this issue of **21C** or ring us on 03 663 3281 to make an order and we will bill you. If writing, our mail address is **21C** magazine, GPO Box 1612M, Melbourne 3001. e-mail: subs@21c.com.au

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Cover: Earth rise over moon, NASA

EDITOR'S NOTE

Don Hewett

Sustainable Development: where there's a will there's a way

WO WORDS SEEM A small step towards saving the world. But the phrase sustainable development contains the seed of a powerful idea, one that could, if we had the will, change our destiny.

The potency of the idea is in the combination and the consensus. From the great mass of the green movement to the mining companies and the major corporations represented by the Business Council, there is agreement about one thing: our activities must logically and inexorably be sustainable, or we as a species will not be.

Sustainable development is an idea for our time. How we work out the future of development is sure to be controversial, but we can't just throw a lever and stop civilisation in its tracks. Even if it was possible, it would be a cure worse than the disease. The challenge is

to maintain and enhance our culture and all the benefits we have won from science and technology.

We must learn from our mistakes, but our mistakes will have

been truly in vain if we lose sight of their role in the spectacular development of mankind. Humanity in so

many ways has used its time well, and we must celebrate these achievements even as we redefine our lifestyles to meet the demands of a new millenium.

This issue is full of exam-

This issue is full of examples of how our knowledge is expanding in areas vital to our

wellbeing, our understanding, and our ability to enjoy life: like the impending capacity to eradicate congenital diseases such as haemophilia through understanding our genes, or the South Australian computer breakthrough that might turn PCs into supercomputers, and even such seemingly remote pursuits as the search for the neutrino, a particle as elusive as it is abundant, and one which could confirm both the structure and the destiny of the universe. They are reminders of the great strides our species has made since we stepped from the jungle of ignorance and superstition into the light of mod-

ern knowledge.

Footnote: Illustrating many of the articles in our special report on sustainable development is an elegant aerial photo essay by Ballarat photog-

rapher and pilot Lindsay Stepanow, self-pictured here at the top of a loop during a shoot.



STOP PRESS: ALCHEMY IN REVERSE

Norwegians change gold into stone

The next winter Olympics will be the 'Green Olympics', host nation Norway has decided. Medals will be made of stone and skaters and skiers in the Games village restaurant will eat off edible plates. Any uneaten plates will be fed to the pigs. Olympic torches will burn eco-friendly bio-gas, and in

shooting events bullets will ricochet into containers, preventing lead contamination of ground water.

The origins of the green games lie in arguments between the organisers in host city Lillehammer and environmentalists who argued building an arena in a bird sanctuary was not a good thing. A compromise was reached under which the environmentalists would be consulted at all stages (WNT/JA). Go for stone!

'MANKIND' GENDER BIASED

Sir,

If 21C truly wishes to represent progressive societal thought, surely this includes an absence of gender bias?

I was most concerned therefore to see mention of 'mankind' in David Hassall's article 'Cars of today! here to stay'? in your last edition.

Put yourself in women's shoes – how would you like your sex to be discounted in reference to an issue which affects all *humankind*?

Language has a powerful influence on our perceptions of, and reactions to, the media.

I sincerely hope this oversight does not occur in the future.

Rebecca Wigney North Fitzroy, Victoria

Ed: Since humankind also contains the word 'man', surely this is splitting straws. Even 'hupersonkind' wouldn't help. And what do we do with woman?

A PACKAGING PROBLEM

Sir,

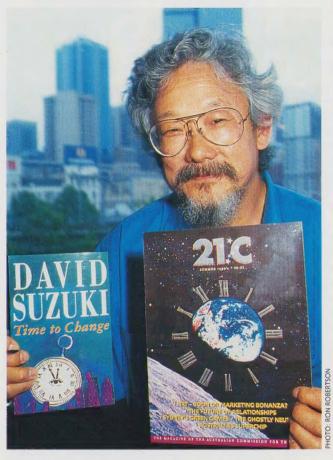
I am not able to recommend your magazine to kindred spirits despite the fact that it does contain some worthwhile information.

I am not prepared to pay for a four-page advertisement from the packaging industry.

I fail to see how importing milk carton material from Scandinavia can be an environmently-friendly packaging option.

Harry Johnson Whiteside, Queensland

OPTICAL CONCLUSION



Time to Change: Environmental advocate David Suzuki was in Melbourne last month with his new book, in time to catch a preview of 21C's Sustainable Development special.

MULTI-SENSOR CINEMA ON THE NOSE

Sir,

I was led by an article in 21C ('Multi-sensor theatre a world first', NEXT, Winter 1993) to see, etcetera the Experience Australia feature, which was promoted as covering our "50,000 year history". In fact very little time is given to Aboriginal history, with most of what is given devoted to 1788 and afterwards. The theatre system system is good but the images look to have been

chosen because they were readily available and cheap. The longest sequences mostly were those about violence — such as Aborigines vs. whites, Eureka stockade, the major wars, and nature's violence in bushfires — but the pictures used were a striking example of poor selection of visual material for the most part, considering what must be available.

Denis Fisk Division communicator CSIRO Division of Applied Physics West Lindfield, NSW

E-MAIL

To: Ed@21c.com.au Subject: Great magazine Sir.

Thank you for such a great magazine. I am very pleased that 21C found its way to our magazine store at Warkworth (rural town one hour north of Auckland City). I am a first time buyer. I like the size, format and layout. It is very topical and timely, particularly David Eyre's article 'IT Goes Bush'.

Thank you for producing this very worthwhile magazine.

From: Roger Mackenzie
<rogerm@hindin.co.nz>

To: Ed@21c.com.au

I liked your latest issue (my wife thought that the other format was more aesthetic, but we agreed that this was probably more practical). I'm so glad you've finally got an e-mail address (what took so long?). After all, if any magazine should have one, then a 'futures' magazine is a prime candidate.

I also applaud your move to articles based on research. I've long admired the depth shown in such publications as *Scientific American*. I think they show that difficult subjects can be made accessible to laypersons. You're well on your way of taking that philosophy to heart.

Lastly, re Rick Slaughter's article on 'Studying Futures': Hear, hear – Australia should get in on the game with more effort!

From: Richard de Rozario <100026.3546@compuserve com>(somewhere in cyberspace)

Greening the Games: hype springs eternal

Sydney's New Millenium Olympic Games has put the city on the podium of very serious media exposure. Having snatched the torch on an environmental ticket, Australia now has a moral obligation to stage a truly sustainable get-together. But is this really likely? Or will it just be another mega-development boondoggle, dressed up in a giant green polyester sweatsuit?

HE OLYMPIC GODS have bestowed their blessing upon Sydney, and Australia's leaders and media bathe us in its golden glow. We feel good again. We won. We are a nation united in celebration. The regional and national economy is about to surge, or at least be jolted. Great psychological, political and financial capital stands to be gained. If cleverly handled, Sydney's urban efficiency and

life quality will receive a permanent boost, as Olympic cities such as Munich and Barcelona have demonstrated. And what's really exciting about Sydney's 2000 plans is that they'll be environmentally correct, having been endorsed by Greenpeace International, our Global Green Conscience. Their muchtouted features spell eco-galore: energy efficiency, habitat healing, waste and water recycling, the sealing off of toxic soil.

Never mind that the dreams of economic salvage and national redemption may not come true. Never mind the understandable exaggeration of what may be at best a short-term opportunity to reform regional planning, or even only a quick fix to some sectors of our economy, or at worst, a hefty 21st-century tax debit.

What we want to know is just how green are our Games, how 'environmentally sustainable' can they possibly be? They are green, certainly, in the sense that within the framework of the Olympic Games, and within the limita-



tions of Sydney 2000 planning concept, they aim to do the right thing, state-of-the-art stuff. But *sustainable*, no - if sustainable means that our environmental accounts will not seriously balloon on the debit side. No one really claims that the Games are environmentally sustainable, whatever that term may mean. And as time goes by and pressures mount, the green sheen may not be sustained either. It is likely to fade, having served its various purposes.

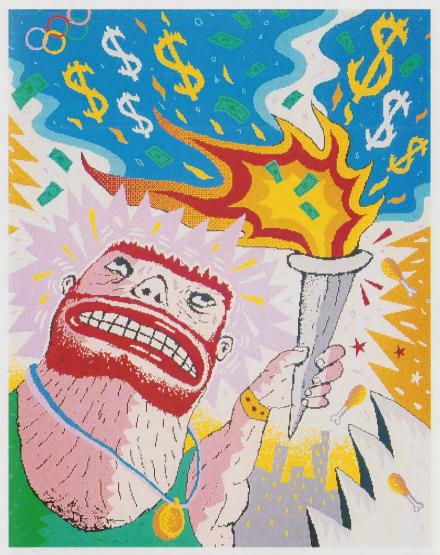
Greenpeace and Sydney 2000 have stumbled into their marriage of convenience on the heel of a blind date, the anonymous Olympic Village competition for Homebush Bay, yielding the Greenpeace team as one of five winners. It was not love at first site but, rather, a stroke of luck, seized in spirited savvy: Sydney's Greenpeace constituency is one of the very few in the world with an urban conscience, targeting cities and urban development as key villains in the global eco-mess. Few realise that the Manchester and Berlin bids really ought to have scored some serious green

brownie points as well. Their campaigns suffered from a Greenpeace Gap.

To hopeless cynics, truegreen environmentalists, and those just green with envy, Sustainable Olympics, if anyone actually had the nerve to use this expression, would win gold in the Heavyweight Oxymoron class. To them, the Greenpeace-endorsed Sydney 2000 is a Herculean contradiction in terms, late-20th century greenspeak at its

best. They say that the idea of a Green Olympics is a perfect illustration of what is wrong with our unsustainable notions of sustainability. The concept, they argue, while perfect for the three weeks in 2000, is almost all wrong for the post-Olympic age: the isolated, over-venued site soaks up scarce public funds and tends to reinforce our utterly unsustainable car reliance, while inner-urban lands languish, little used.

Sure, these misolympian Philistines will mockingly concede, there will be an extraordinarily creative and expensive shuffling around, and clay-capping of the poisoned earth in Homebush Bay. Sure, there will be some nurturing and preservation of mangrove forest patches and animal breeding grounds. And sure, there will be a carefully oriented Olympic Village, sporting the best of eco-technology and common sense in urban design. But let's face it, our modern Olympics are a muscular slap in the face of any Deep Ecologist. A massive fleet of intercontinental Olympia-bound passenger and cargo aircraft will churn



greenhouse gases and ozone-depleting chemicals into high layers of the atmosphere - at a time when sanity should dictate a halt to all non-essential flights. Cubic kilometres of concrete – one of the least sustainable of all construction materials, barring steel – is poured into largely luxurious landing strips, highways and venues, venues and more venues, not only in Sydney, but also in the furiously proliferating, identical stadia that have been started in vain, and in defiance of the odds, in bidding cities around the world. The already universal junk food frenzy will receive a universal boost as advertisers bombard a captive audience. Another generation will be conditioned to the dogmas of unlimited growth and individual competitiveness at any cost,

perpetuating the myth of higher, faster, farther, mightier – a global affirmation of Euro-rooted male supremacist values. Another gasping construction boom squeezed out of a structurally ailing world economy, like the last bit of toothpaste.

The eco-hardliners will recall that over the past decade, green rhetoric has proliferated amid wide-eyed optimism about getting a grip on the mounting environmental disaster, whether in urban strategies or pitches for biodegradable soap. To them, the Olympics are no exception, just the latest megadevelopment boondoggle, dressed up in a giant green polyester sweatsuit.

Such breathless, easy mongering of criticism smacks of pompous party-

pooping and Olympic spoil-sporting. But there *are* some basic dilemmas in the notion of a Green Games. They are as fundamental as another Olympic paradox: the espoused sharing of 'the Olympic spirit' and universal harmony in the face of nationalist, subtly supremacist sentiments, an aspect of the Games since their inception.

It is not easy to reconcile the requirements of a fail-safe, highly exposed international event with those of efficiently and imaginatively meeting regional development needs - 'good' Games demand a close concentration of venues, perfect surveillance and tight security perimeters, while by contrast, good city development demands a distribution of resources across space and over time, adaptive re-use and openness. However, a key driving factor in hosting the Olympics is broadly shared hopes for betterment. How this 'betterment' is to be achieved ought to be subject to careful public scrutiny.

Until we learn to happily marry both sets of interests, we will remain a long way from solving a basic dilemma of urban development, sustainability-wise: how to fundamentally transform our approach to development, and embrace principles of *envelopment* instead. Until we do so, we will stand transfixed, squinting hopefully into the green limelight as we watch another go-go development party coast down another lucky hill, cheering wildly while running on empty, confidently skipping the petrol station and the public transit stop.

When Pierre de Coubertin packaged European fin-de-siécle zeitgeist into his universalist Olympic dream, he triggered what looked like a fizzling missile: the first Games barely got off the ground. Not until much later did it become apparent that they were the perfect medium for the media age: a mass conditioner of global values, a Golden Fleece to be craved by the aspirants to the World Achievers' Club, harmoniously clad in Levis, sipping Coke and munching Kentucky Fried

"Sustainable Olympics, if anyone actually had the nerve to use this expression, would win gold in the Heavyweight Oxymoron class."

HE SYDNEY OLYMPICS IN 2000 is already testing the ingenuity of urban planners and designers. The latest scheme for solving the city's urban sprawl is to move the problem offshore.

Dr Nicholas Marinov, an architect at the University of New South Wales, has called for a 'harbour option' that would heavily exploit Sydney's greatest natural asset – 120 kms of waterfront. The option, which includes a big expansion in ferry services, would be the most efficient way to link central Sydney with the sprawling suburbs out west, he says. Harbour-wide transport would also help integrate the long term development of the city with Homebush, the proposed site of the Olympic village.

The NSW Department of Planning recently unveiled plans to develop higher-density housing along proposed road and rail transport corridors between the city centre and Parramatta.

Marinov rejects the Department's thinking and instead proposes more urban development along the city's foreshore, which currently has a lower urban density than the city average.

"No other city has foreshores of such length and magnitude. The harbour cuts the city in two, with a regional centre at each end. We could reverse the trend of 'urban sprawl' by attracting people from inland towards our extensive foreshores," he said.

Marinov rejects claims that foreshore development would further pollute Sydney Harbour. "The celebrated city waterfront of Lake Leman in Geneva is heavily built up, and yet you can drink the Lake water. Development will enhance the harbour, not destroy it." drums from five-ringed buckets.

The world needs great events of sharing to buffer it from its daily traumas, from Bosnia to Bougainville. But while we dream of harmony, we remain fundamentally in contest, and our dominant cultures are increasingly engrossed in commercialism. What can Australia do to demonstrate that it is intellectually capable of transforming symbolically and practically what Paul Keating has called the "greatest international pageant of our times" so that it truly faces the issues of our future? If Baron de Coubertin were alive today, how would he counsel us?

Pierre would probably be pleased by the great advances made in the Games. He would be thrilled by the fact that, a full century later, the creative tension between the eternal and the ephemeral which so very much underlies the Olympics has again become the fin-desiécle issue, affirming the Games as a critical paradigm for our run-and-hit approaches to development, an elusive symbol and yet a tangible vehicle for hope.

Today's Games are captive to emerging mass communication technologies, and their economics: photographic reproduction, cinema, radio - and now television, by satellite, cable and soon by the former telephone. But as a vehicle of hope and as a mass medium, they are also inherently receptive to mass sentiments - and a global fear of ecological doom is inexorably rising. Granted, the Olympic impact on the environment is miniscule, even insignificant, when compared to our massive daily ecological onslaught on the life-sustaining capacity of this earth. However, the symbolic role of the Games, its function as a message, development model and cultural paradigm, is controversial - and will be more so in the future.

Munich in 1972 and Los Angeles in 1984 were perhaps the first 'Green' Games. In Munich, the emphasis was boldly placed on public transit and pedestrianisation of the inner city, resulting in an extremely visionary suppression of the automobile, visionary for late 1960s planning concepts, that is. And Los Angeles minimised new construction, stressing re-use and adaptation of existing structures, and concentrated unabashedly on celebrational, 'virtual' venues. No, the International Olympic Committee (IOC) had not gone soft. This great innovation was a fluke, and only possible in this form because the city was the only Olympic contender at that time and in a very strong bargaining position indeed: the city and its taxpayers did not have to underwrite the costs. This is where the resource conservation aspect ends: the LA Olympics still served as a monumental advertising billboard for business as usual.

LYMPIA 2000 WILL BE HELD at a crossroads. In one direction we see more of the same – a string of great international pageants going off in living colors, yet inexorably, like so many fireworks, leaving behind big puffs of smoke. In the other there is greater daring and inventiveness, a resource-conserving and symbolically sophisticated Olympics-stimulated urban healing process, positively affirming the physical, high-touch sweatiness of the real, the here and now, the permanent transience and exhilarating glory of world cities at their best. The richly mixed lessons taught by the best 'civic' Olympics, such as Munich and Barcelona, will continue to serve as the basis for great innovation in resource conservation and efficiency in venue provision, both in the short and in the long term, and in city form.

It might well be sensible – yet utterly unreasonable – to expect the IOC to issue stringent environmental performance guidelines and enforce them, just like they imperially insisted on an extravagantly spiralling splurge in 1976 Montreal. What we need to come to grips with is that perhaps the greatest





Olympic achievements have been the brilliant and renegade innovations in city building coming from the competing cities. These few maverick achievements owe their impetus to the Games but their realization to the vision and intelligence of the women and men that negotiated the best, most sustainable deal for the long run. This relatively thin history of Intelligent Games is awaiting another chapter now, at this, our time, when unprecedented environ-

mental and technological issues continue their race seemingly on their own, raising the spectre of the game to end all games – humankind's environmental and technological end-game. We can no longer say 'it's just sport' or 'we share the spirit'. We must try harder to understand what sort of spirit, with whom we are sharing it, and how on earth we are going to make headway in the race to salvage the earth.

We cannot expect real Olympic

The Sydney Olympics (top): An artist's impression of the proposed Olympic complex for the 2000 Games, The green village (left): An artist's impression of the athletes' accommodation at Homebush Bay.

planners to worry about such speculative stuff. They must ensure that all goes well in 2000. (Im)possible futures are clearly what our Olympic sceptics should sink their teeth into. But in the likely event that these questions are too cumbersome for them, there always remains the cop-out of couch potatoes: musings about neo-Dadaist, alternative Games. Olympics without stopwatches. Olympics of silence, quiet and peace. Olympics of missed deadlines and missed airlines. Olympics of fasting. Olympics of staying home. Olympics of ideas and poetry. Olympic races towards cancelling foreign debts. Olympics of scrapping active weapons deals. Olympics of ideas on how to eliminate the root causes of war. And a moratorium on the Games until we have seen some environmental impact statements.



Since the publication of the book "Our Common Future", by the World Commission on Environment and Development six years ago there has been a noticeable wave of concern about the ability of the Earth's natural resources to sustain human civilisation.

In Australia, the National Decade of Landcare underlines our interest in this subject, as does the Inter Government

Agreement on the Environment, recently jointly agreed by the Federal and State Governments.

Many articles on sustainability have been written. It would be easy to list 1000 of them. But these words and ideas are useless unless sustainability becomes a practical reality. Translating sustainability into practical action is nowhere more important than in the water industry. At **MELBOURNE WATER**, we are turning the words into deeds.

Across Australia, integrated catchment management is being used as the main vehicle for implementing the sustainability ideal. **MELBOURNE WATER** is part of this movement. While our rural communities are facing up to the challenge of managing catchments on a sustainable basis, the same need is every bit as real in our most populated, urbanised areas.

MELBOURNE WATER - Australia's leading urban water authority - has developed a practical program for measuring up to the sustainability challenge.

However, sustainability for Melbourne cannot be achieved by **MELBOURNE WATER** alone. To create a sustainable Melbourne requires the co-operation of other agencies and indeed of the community as a whole. We aim to help our colleagues and customers join us in this important commitment.

An encouraging sign of Victoria moving toward sustainability is the efforts by the Government to prepare legislation on integrated catchment management. This will provide a valuable lead for the community in establishing a framework for co-operation.

Another encouraging sign is the improved communication and co-operation between the environmental regulators, industry, community groups, agencies and governments at all levels. Given more of this, Victoria's environmental future is looking good.

PRINCIPLES OF SUSTAINABILITY

- Conservation in the sense of protection is better than re-creation (prevention is better than cure).
- The precautionary principle (avoiding unnecessary risks) should be applied in any trade off situation (especially where the trade-off involves an element of the environment).
- Stocks of ecological capital (as with other capital assets) should not be depleted.
- Unavoidable use of un-recreatable resources should be as efficient as possible (e.g. oil).
- The thresholds of environmental capacity should be established. Resource management arrangements should respect these limits.
- Whole system (as well as local) criteria must be satisfied implying an holistic or ecosystem wide approach.
- Changes should be incremental and the effects monitored to allow for adaptive management.

MELBOURNE WATER'S ENVIRONMENTAL POLICY

- Melbourne Water is committed to playing a leading role in improving the urban environment for present and future Melbournians.
- 2 Melbourne Water considers
 that responsible management
 of environmental issues is an
 essential part of achieving its
 objectives. Accordingly,
 wherever practicable
 Melbourne Water will carry
 out its functions and exercise
 its powers in ways aimed at:
- protect the health and safety of its employees, its customers, the public and other aspects of the environment.
- improve its awareness and management of environmental issues and reduce any adverse impact of its activities on the environment.

- interpret, promote and apply the following key principles to the management and development of its operations:
- ecologically sustainable development
- integrated catchment management
- resource conservation
 'best practice' environmental management.
- 3 Responsibility for implementing this policy will be shared in the following way.
- ► Melbourne Water:
- establish broad policies to give direction to responsible management of environmental issues and obligations
- monitor implementation
 of Corporate environmental
 policies and programs
 and performance of
 the Corporation's
 statutory obligations.

 valuate the Corporation's performance and initiate any desirable changes.

Managers will:

- develop and implement supplementary environmental policies and specific programs to achieve these objectives
- make regular, detailed reports to the Board on the way environmental policies are being performed
- develop and implement appropriate training programs for staff on environmental management issues.

Staff will:

 perform their functions in a manner consistent with the Corporation's environmental policies and help identify ways to better achieve these objectives.



An enterprise of the Melbourne Water Corporation



SUSTAINS

MELBOURNE WATER ENVIRONMENTAL
MANAGEMENT SYSTEM

Environmental
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Environmental
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Management Plans

The controversial menopause

Menopause is both a product of a woman's biology and the society in which she lives. While women in some cultures see it as a normal developmental phase in life, Western women are being persuaded to see it as a disease and are seeking to 'stay young', as one drug company executive put it, through hormone replacement therapy. HRT, as it's known, is now used by an estimated 200,000 women in Australia, and the 'menopause industry' is already worth about \$40 million a year in pharmaceuticals alone. But the promotional information on HRT appears to be overstating the benefits and ignoring

Organisation defined health as a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity. Member nations agreed to a target of health for all by 2000 and, implicitly, accepted this positive construct of health. Yet a focus on symptoms, diseases and disorders continues to pervade much of the medical literature.

This tardiness and focus on ill-health is equally evident in research on the menopause, where the obsession with pathology and medical treatments has prompted increasingly vocal critiques of the apparent medicalisation of a normal part of women's experience.

The contemporary Western medical description of menopause as 'ovarian failure' or 'estrogen-deficiency disease' defines the midlife woman as 'sick'. 'Treatment' with Hormone Replacement Therapy (HRT) is required to counteract the declining production of estrogen by the ovaries. This view of menopause as a 'hormone-deficiency disease' began to appear in scholarly articles in the 1930s. In 1966, Dr Robert Wilson's book Feminine Forever described women in midlife as in 'living decay'. He asserted that menopause could be likened to a deficiency disease, similar

The alternative view, argued by

Germaine Greer (*The Change*, among others), is that menopause is a part of the life cycle, a normal developmental transition, a time for continued growth and development, for meeting new challenges and developing new skills. This may involve change or growth of self, biologically, psychologically and socially.

Greer argues that when we give menopause a medical meaning by defining it in terms of health and illness, we are changing its social meaning as a marker of the end of the reproductive phase of a woman's life. Once menopause is seen as a hormone deficiency, medical practice (in the form of HRT) is then necessarily used to correct the hormone deficiency, which is held

responsible for the problematic experiences occurring in mid and later life.

Major disadvantages accrue from the medicalisation of the menopause. These include the reinforcement of the idea that women are controlled by biology in general and their reproductive systems in particular. The labelling of menopause as an illness may then preclude

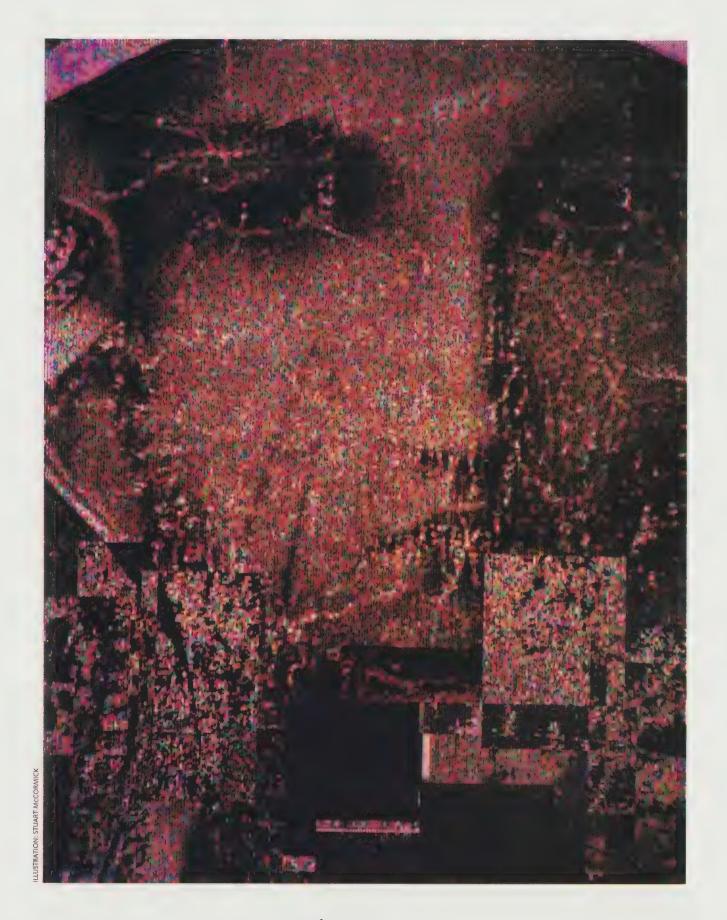
women, friends and family from examining the other circumstances of women's lives which contribute to problematic experiences.

It is important to distinguish between experiences directly related to menopause and those related to ageing; the two are not necessarily synonymous. As a society we are frightened of old age, and menopause is seen as a signal of old age in women. Our culture tends to have a negative picture of menopause and promotes the idea that women are a burden at this time of their lives — an attitude that makes women more vulnerable to the view that menopause is a 'deficiency disease' requiring HRT treatment.

Biologically, the 10 years

encompassing the menopause see a progressive decline in ovarian function. Post-menopausally, relatively low levels of the ovarian steroids (estrogen and progesterone) and high levels of gonadotrophins are found, and the cyclical hormonal changes of the reproductive years are reduced. The extent to which other factors (especially social ones) interact to

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THE HIGHER SOCIOECONOMIC CLASSES."



21°C** SUMMER 1993/4

determine immediate and longer-term health outcomes has not been adequately assessed.

Psychologically, during menopause, the woman must deal with her changing hormonal internal environment, her loss of reproductive potential and the transition into mid and later life. Socially, she is confronted by many problems in midlife – adolescent rebellion and children leaving home (or returning), the physical illness of self, partner or parents, and marital problems relating to midlife transitions.

A number of studies have shown that negative attitudes to menopause predict later occurrence of symptoms. The majority of women report either feelings of relief or neutral feelings about the cessation of menses, and attitudes to menopause become more positive as women pass through the transition. Thus a positive change in attitudes to the menopause and to ageing may have a beneficial effect on menopausal symptoms.

Various sociodemographic variables, such as educational level, occupational status, income and social network, may influence the way in which women adapt to the many changes occurring in the menopausal years. Cultural factors such as

change in status accompanying menopause and stereotypic attitudes to ageing and reproductive roles may also be influential.

Menopause is as much a cultural experience as a physical one, and a woman's transition through this period of life is affected by our society's beliefs, expectations and customs regarding menopause and older women. Sandra Coney in her recent book *The Menopause Industry* points out there are as many different menopauses as there are cultures – while the cessation of menstruation is common to all women, symptoms can vary from culture to culture. Studies in

Asia have shown that menopausal symptoms are not nearly as severe as those recorded in studies in the West. A study among Rajput women in India has shown that they have very few problems associated with menopause. For these women, menopause was perceived as a reward. Where previously they had lived veiled and secluded in purdah, they could now leave the women's quarters and join in the men's talking and drinking activities.

ESPITE THE UBIQUITY OF menopause in Western societies, very little is known concerning the normal range of experience of this event and the factors which may affect it. Some women experience very little bodily or psychic change, while others have their quality of life disturbed by symptoms which are claimed to affect many bodily systems. The most frequently experienced symptoms are those of hot flushes or flashes

and night sweats (the so-called vasomotor symptoms). Some women find vaginal lubrication with sexual arousal more difficult with the menopause, and this may affect sexual enjoyment. Problems with the urinary tract may become more frequent

after the menopause. Osteoporosis, cardiovascular disease and urogenital disorders have been implicated as long-term consequences of the cessation of ovarian endocrine activity associated with menopause.

Prior to the population-based studies, knowledge of menopause was based on a small proportion of self-selecting, predominantly ill women. However, prospective data have demonstrated that menopause itself does not cause poorer health (either physical or psychological), and women can be reliably informed that very few symptoms appear to be related to the endocrine changes of the menopause.

The prevalence of hot flushes ranges from 0% in Mayan women to 80% in Dutch women. Hot flushes and sweats are common throughout Europe and North America, and while social factors in these countries may to some extent predict who is at risk, menopausal status per se seems to be the primary causal factor. Even so, a certain percentage of women report hot flushes many years before the menopause begins and hot flushes reach their peak with the actual cessation of menses. Other symptoms, such as depression, seem much more strongly related to factors other than the actual menopause. Hysterectomised women suffer more severe symptoms overall than women who reach menopause naturally.

Not surprisingly, studies of women seeking help at menopause clinics or from their own physicians often find a high level of symptoms - patients who consult their doctors are not typical of women in the general population and can be expected to report more symptoms. Social scientists, on the other hand, who attempt to look at climacteric symptoms in a population at large, usually find a lower level of symptoms, though their populations often exclude women who have had hysterectomy, and sometimes those who are taking hormones for their symptoms, resulting in samples that are healthier than the general population.

Ballanger, of the University of Sydney, found that women seeking medical help for their climacteric symptoms reported the same incidence of hot flushes (75% to 80%) and vaginal dryness as women aged around 50 who were approached by researchers in a shopping centre. However, those seeking help had more psychological and certain other symptoms, such as sweating, palpitations and paraesthesia.

Oldenhaave, of the State University of Leiden in The Netherlands, reports that nearly 80% of Dutch women have experienced hot flushes, the peak prevalence being in those whose last menstrual period occurred between six



A polarised light micrograph of crystal of estrone, one of the six naturally occurring estrogens, a class of hormones associated with the development of female reproductive organs and secondary sex characteristics. Estrone sulphate may be used in HRT to treat some clinical symptoms of the menopause.

and 12 months prior to the survey. Oldenhaave found that flushes and sweating seem to be related to the severity of nearly all other complaints. A survey of women recruited from an ovarian screening clinic at Kings College Hospital, London, found that 15% to 25% of women had hot flushes before the menopause. As they reached the menopause, the incidence of hot flushes rose to 54%.

In Europe and the USA, the women most bothered by the climacteric are those in the lower socio-economic classes. In Asia, the situation is exactly the opposite: the most severe symptoms are reported by women in the higher socio-economic classes.

As there were few adequate data regarding Australian women's experiences of the midlife years, the Melbourne Women's Midlife Health Project was developed to determine Australian women's experiences of the natural menopausal transition. The cross-sectional survey allows international comparisons and provides a baseline for further longitudinal study of premenopausal women through their climacteric years.

Melbourne study, a random sample of 2000 Australian-born women living in Melbourne and aged between 45 and 55 years was interviewed by telephone. Of the 70.6% of women eligible and available for the study, 17% were premenopausal, 29% were perimenopausal and 19% were naturally postmenopausal. (The perimenopause is characterised by changes in the frequency of menstrual flow, including an absence of menstruation for up to 12 months.) An additional 22% had undergone hysterectomy, with

or without ovary removal, and 21% of the sample were taking HRT. If valid nationally, the sample would suggest that about 180,000 Australian women in the 45 to 55 age group were on HRT.

Most studies have focused only on complaints, failing to balance these against positive aspects of health and well-being. However, the Melbourne Women's Midlife Health Project uses a validated well-being questionnaire to measure positive aspects of psychological health.

Although negative stereotypes about midlife abound, suggesting that women in this age group tend to be depressed and irritable, the results of the Melbourne study indicate that the majority of Australian mid-aged women report positive moods – from 55% to 72% said that *most of the time* they felt satisfied, clear-headed, useful, loving, optimistic and good-natured –

not exactly conforming to the popular image of the miserable, distressed menopausal woman! Moods (positive and negative) were profoundly influenced by social factors (such as marital status, employment, education, attitudes to menopause and ageing, stress), lifestyle factors (such as exercise and smoking) and health status. Some minor changes in moods do occur just prior to menopause, but these are transitory.

Interestingly, the Melbourne Women's Midlife Health Project found that most women do not see menopause itself as a big problem. Thus well-being does not seem to be related to whether a woman is menopausal or not, but rather to health and lifestyle factors, positive relationships with family and friends, having other interests and work, and having positive feelings about getting older.

The number of bothersome symptoms reported in the two weeks prior to interview varied significantly with the menopausal transition. Premenopausal women were the least and perimenopausal women the most symptomatic. Menopausal status was significantly related to only two groups of symptoms: vasomotor symptoms, which increased through the menopausal transition, and general somatic symptoms, which were more frequent in the perimenopause. The Melbourne Women's Midlife Health Project found that hot flushes are not a problem for the majority of menopausal women; only 39% reported them as bothersome. The Australian population study found that the reporting of negative symptoms was associated with similar factors to those affecting mood.

Women in, and approaching, midlife have been confronted in the last few years with a rush of information about menopause and the use of hormone replacement therapy (HRT). Yet HRT is not new. Since the 1950s women have been treated with various combinations of hormones after hysterectomies or for menopausal symptoms such as hot flushes and vaginal dryness. Recently HRT has also been promoted as a preventative therapy for osteoporosis and heart disease.

Conflicting messages are creating uncertainty and even guilt in some women, who have been made to feel they should be taking HRT but do not like the side effects, pill-taking, or continuation of menstruation which accompanies HRT usage.

HRT has an important role to play in the alleviation of hot flushes and sweats and urogenital atrophy. These symptoms have shown to be responsive to HRT in double-blind placebocontrolled trials in naturally menopausal women.

HE ROLE OF HRT IN LONGERterm prevention of osteoporosis and cardiovascular disease is unclear. It is not yet possible to generally recommend indefinite HRT purely for the prevention of cardiovascular disease and osteoporosis. Where there is an increased risk for these disorders, a discussion of the potential benefits and side effects may enable the woman concerned to make an informed choice.

The debate around HRT usage is currently focused on these benefits and side effects. For some women, HRT is liberating - it can help control hot flushes and bladder problems, and estrogen creams can alleviate vaginal dryness and prevent infection caused by fragile vaginal tissue. However, many women using HRT complain of side effects

such as fluid retention, nausea, weight gain and sore breasts. Unusual bleeding patterns are a problem, and must be examined in case they are caused by other complications. Overseas studies have found that women using HRT have a higher hysterectomy rate and a greater number of gynaecological procedures performed.

Much of the promotional information about HRT ignores both the potential risks associated with it and the fact that information about the beneficial effects usually comes from research on women taking estrogen alone. Estrogen-only therapy is known to be associated with endometrial (or uterine) cancer, so that women now are more often prescribed estrogen with progesterone. There is also evidence that estrogen is associated with an increased risk of developing breast cancer or gall-bladder disease as well as irregular bleeding patterns. It is suspected that progesterone will reduce the beneficial effect of estrogen therapy on cardiovascular disease, and its effect on other symptoms is unknown. Large clinical trials now getting underway in the USA will hopefully answer some of these questions in the next few years.

Because not enough research has been done on these drugs, it is difficult to give women a clear picture of the risks and benefits. In the long term, patterns of disease are changing in our society; for example, the incidence of heart disease is decreasing and the incidence of breast cancer increasing.

> This makes it even more difficult to assess whether HRT will have clear benefits in 15 to 20 years' time.

> Furthermore, many of the risk factors identified for later specific outcomes (such as osteoporotic fracture or coronary artery disease) are common to other diseases, so their elimination may carry

many benefits. Women should be encouraged to eliminate cigarettes, minimise alcohol use, improve their diet and exercise more.

We have clear evidence that Melbourne women do not have a high enough calcium intake to maintain bone health. Bone density can also be increased with adequate weight-bearing exercise – a recent two-year

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Another polarised light micrograph of crystals of estrone.

study found that weight-bearing lowimpact aerobic exercise designed for 'seniors', performed twice weekly for 60 minutes, had a significant protective effect on bone density.

Improvement in diet includes reducing salt, animal protein and caffeine, and ensuring an adequate amount of calcium. Calcium supplementation of 1000 mg per day in postmenopausal women with mean dietary intake of 750 mg per day significantly slows bone loss. For prevention of cardiovascular disease, attention should be given to decreasing fats and increasing vegetables and fruits.

There is a case for HRT for hot flushes, night sweats, vaginal dryness and some urinary problems. But remember that even then, other factors are associated with a reduction in hot flushes and other symptoms: education, better health, fewer drugs, low stress, not smoking, weekly exercise, and having positive attitudes to ageing and menopause.

Because menopause is not associated with positive or negative moods, there is no case for prescribing hormones for unhappiness. However, other factors are associated with well-being, including living with a partner, good self-rated health, absence of interpersonal stress, not smoking, exercising for health and fitness, and positive attitudes to the menopause and ageing. Most of these are clearly things we can do something about, utilising techniques which will lower the level of stress arousal, for example, or seeking specific counselling to resolve ongoing marital or sexual problems.

The facts are simply not in yet on whether taking HRT will significantly decrease cardiovascular problems or reduce fractures, and whether this would justify recommending HRT therapy to most women in midlife. The disadvantages or risks, such as increased

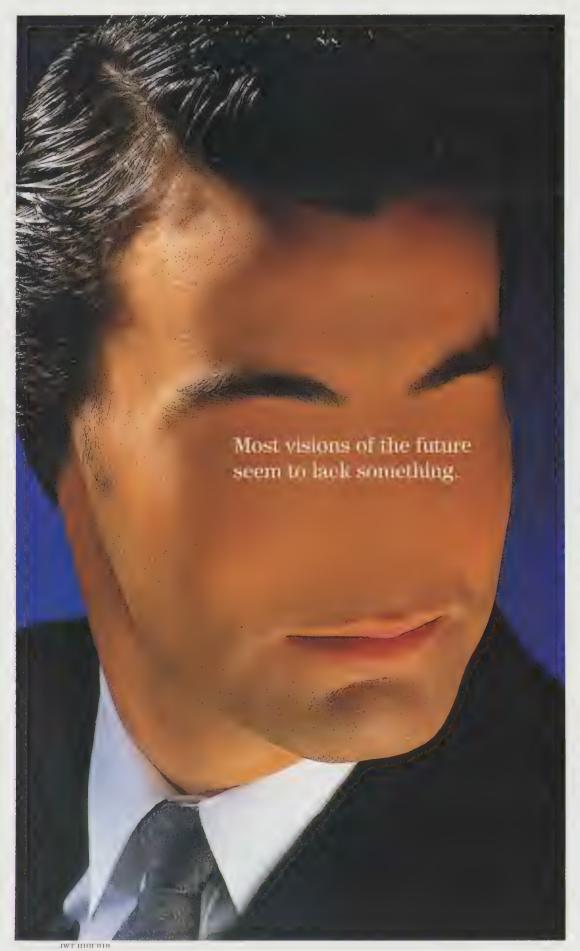
breast cancer, have still to be adequately documented.

Women's opinions on HRT vary widely. Some would not consider it; others think it is wonderful. Some think it is good but hate the side effects. An individual woman's decision to use or not use HRT is most often based on its immediate positive or negative effects for her.

Acknowledgments

Co-investigators on the Melbourne Women's Midlife Health Project are: Henry Burger, Lorraine Dennerstein, Peter Ebeling, Adele Green, Janet Guthrie, John Hopper, Carol Morse, Maggie Ryan, Julia Shelley, Anthony Smith, John Wark.

This project has been funded by the Victorian Health Promotion Foundation, The Percy Baxter Trust and the Australian Dairy Corporation.



When people imagine some future technological time, they only ever seem to think of computers. Oh, and maybe communications. And that's it.



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Edited by David Eyre



Jurassic Park down under

Liz Tynan

ustralian National Uni-A versity archaeologist, Tom Loy, whose research informed the central hypothesis of the blockbuster movie Jurassic Park believes that it might actually be possible to bring creatures back from extinction.

"The technology that has been suggested is not as crazy as it sounds. If we want to do it, we probably can. It is just about as crazy as trying to send a man to the moon," said

"The huge scale of the resources has to be kept in mind ... To recreate an animal, whether it be a dinosaur or a dodo, you would have to know the creature's entire genetic

"It may well be that in 50 or 100 years we will know the complete genome sequence for a large number of animals. We then have to decide whether we want to confront the issue of bringing something back from the dead."

Loy's is the only non-fictional name to appear in Jurassic Park, written three years ago by Michael Crichton, and the basis of the mega

Loy, a pioneer in the analysis of ancient DNA, has never met or spoken to the author, but believes Crichton saw an article which described his (Loy's) work on extracting proteins from bone. In that article, Loy speculated about the possibility of obtaining the genetic material DNA from ancient specimens.

"I really admire Crichton and also Spielberg for picking up on it, because in many respects I think Jurassic Park is absolutely a sign of the times, (symbolising the fact) that we are surrounded by a new technology and we have no idea



The opalised skeleton of an early Cretaceous pliosaur from Coober Pedy, South Australia. No DNA in these bones as all organic material has been replaced by opal.

where it is going to take us," said Loy.

Loy has worked on ancient blood since 1981, when he saw what he thought were blood residues on stone tool surfaces. He found that the necessary blood residues the proteins and the haemoglobin - were there to be analysed.

He also noticed hair embedded in the blood, and saw the chance to identify the animal the blood came from. Through contact with a forensic wildlife officer, he heard about work at San Diego Zoo on crystallising haemoglobin to identify the disease vectors of equine encephalitis, using the bloody contents of mosquitoes' stomachs. Although this particular use for the blood in mosquitoes' stomachs proved futile, it opened other possibili-

While there was much more blood in a mosquito's stomach than on the tools with which Loy was dealing, it was within the same order of magnitude. As the San Diego researchers were able to get meaningful results from tiny samples using crystallisation techniques, Loy decided to try crystallising blood from stone tools, and he spent the 1980s refining his methods.

However, his research didn't get far until the advent, in the late 1980s, of polymerise chain reaction (PCR) techniques. PCR enables scientists to take very small amounts of genetic material and 'amplify' it to a usable

Loy has been working closely with Dr Klaus Matthaei from the John Curtin School of Medical Research on amplifying DNA. They can now routinely amplify a single fragment of a single gene from a single cell. This means only the tiniest traces of blood are

"There has been a mad scramble to adapt the methods of PCR and molecular biology in general to the absolute junk that makes up a

lot of the ancient samples," said Loy. This junk contains a lot of things - degraded proteins, haemoglobin, various bacteria, and even manganese and other minerals from the soil - which can inhibit the PCR process.

The problem has been alleviated by the discovery of a particular part of the genome of animals, which always varies from species to species.

"This has allowed us to identify species of origin without having to do direct sequencing from an amplified product, which is a time-saver as well as being more informative at the level that we need. We want to know what the animal was and we are not interested in the genetics per se. However, it is easy enough to move to a different area and do some other things like determining the sex of the animal or human and doing taxonomic relationship or genetic evolutionary work.

Loy has developed a number of research directions. For



Alex Ritchie and Tessa Corkhill of the Australian Museum, excavating a skeleton of Diprotodon in Cox's Creek, Tambar Springs, northern New South Wales.

instance, he is examining extinct Australian megafauna such as diprotodons and giant kangaroos, and this has implications for research into the subsistence and economy of prehistoric Aboriginal communities.

"The oldest Australian marsupial we have looked at is a sample in the range 80,000 to 100,000 years old, and we can routinely get DNA from that."

"I want to use extinct Australian marsupials, to see if we can develop a series of profiles of DNA species identification and have that as a library for looking at blood residues on tools, to see if there is a kind of 'smoking arrowhead' around. Were Australian Aboriginals actually hunting these big animals? Right now there is a paucity of direct evidence," he said.

Recently, Loy has obtained DNA from his very oldest specimen – a Jurassic era seadwelling animal, found in Queensland and called a plesiosaur, which died some 160

million years ago. This is quite a breakthrough, opening to DNA analysis creatures of very great antiquity.

ANU Reporter

Artificial lighting messes with seasonal body clock

Artificial lighting has altered natural human sleep and hormonal activity with as yet unknown health consequences, a new study by the US National Institute of Mental Health (NIMH) suggests.

The human brain retains mechanisms — seasonal clocks conserved through evolution — that keep track of what time of year it is by changes in day length, say researchers.

When volunteers were exposed to experimental 'winter' and 'summer' photoperiods, biorhythms reverted to a pattern much like that of

sheep, chipmunks and other animals.

Artificial lighting effectively imposes on us a constant, summer-like, 16-hour period of daylight year-round, masking our seasonal rhythms, but not without consequence.

Researcher, Dr Thomas Wehr, said that the new evidence implies that modern humans may be getting less sleep and exposure to key hormones. This may result in decreased periods of rest, quiet wakefulness and daytime vigor – with attendant fatigue.

"There is a constellation of measurable changes that occur in certain hormones when we use light to expand our days. Some of these hormones control functions such as growth and tissue renewal.

"In animals, the seasonal clock is known to regulate reproduction and other rhythms. Whether this clock is capable of influencing such functions in humans is a question for future research."

The 15 experimental subjects, aged 20-36, went about their normal daytime activities, but spent nights in a windowless dark room for either 8 ('summer') or 14 ('winter') hours. Modern-day humans usually sleep through the night without interruption.

However, during the long nights of 'winter', which lasted for a month, all but a few subjects' sleep separated into two parts with a period of quiet wakefulness in between.

This reverie state was characterized by a prominent and sustained alpha brainwave rhythm, as occurs in meditation.

Such a 'bimodal' sleep pattern, common in animals, suggests that humans share with them a circadian clock in the brain employing two separate oscillators: one that synchronizes us with dawn and the other with dusk, according to Wehr.

Consistent with such a dawn/dusk pacemaker that controls biorhythms, most subjects slept longer overall in 'winter'.

They also developed higher nocturnal levels of growth hormone and longer nighttime secretion of the pituitary hormone prolactin, the pineal hormone melatonin, and the adrenal hormone cortisol. The two latter changes persisted even during a control period when the light/dark cycle was abolished and subjects remained awake in dim light for 24 hours.

"Persistence of the changes under these conditions provides evidence that the brain contains a seasonal clock which 'remembers' the length of the nights to which it has most recently been exposed," explains Wehr.

After a few weeks of 'winter', subjects reported feeling less fatigue, happier and more energetic. "Since prehistoric times, we humans have been subjects in an 'experiment' in which artificial light is used to lengthen the natural photoperiod and suppress seasonal changes in our biology and behavior," says Wehr.

Positive thinking folklore confirmed

Many people believe state of mind affects our health, but until recently it has been just that — a belief. Now there is proof.

A Newcastle University research team has demonstrated the existence of the long-suspected link between positive thinking and health —



the brain can influence the immune system.

According to research team coordinator, Professor Maurice King: "Basically, what we've established is that the brain not only talks to the immune system, but the immune system talks back to the brain and there is a constant intercommunication between the two systems".

In laboratory trials, researchers gave rats a feverinducing drug simultaneously with saccharin water. The next time, the rats were given saccharin without the drug but had the same fever reaction.

The process also worked in reverse, when rats were given a fever, then given a naturally occuring hormone that reduces fever, with the saccharin. The next time these animals were given a fever, only the saccharin was required to reduce the fever.

"We never ceased to be amazed at the results," King said. "The psychological effect of the saccharin can actually suppress a real fever.

"This is not the body pretending to have a response, it actually goes through the physiology of having the fever or suppressing it."

The link has also been shown in human patients. Using volunteers who suffer from allergies, the researchers were able to simulate an allergic response in the absence of allergens.

The volunteers were given a non-allergenic blue-colored drink and had allergens (house dust mites) injected into their nostrils, causing an allergic response.

On their second visit, the volunteers were again given the blue drink but the injection contained only saline solution. The allergy response elicited was the same as when

the injection had been of allergen.

The researchers measured the enzymes that are associated with the release of histamines in the allergy sufferers, and found that they changed in response to the blue drink.

"So it is not the person mimicking the allergic response, it is actually the biochemical and physiological pathway being activated by the brain," King said.

"I think if we can get it right with our allergy studies, the next thing we propose to start on is asthma," King said. "But we must be sure these contentious procedures are right before we proceed to life-threatening conditions."

The group has also studied whether one 'personality type' was more susceptible to allergies than another. They found that the type of person who tends to be prone to allergies is something of a hypochondriac.

"The other surprising thing is that people who tend to be socially introverted (shy) also seem to be prone, and this is particularly true of hay-fever sufferers."

King realises that conditioning techniques that boost the immune system may be a long time reaching widespread medical application. There are fewer barriers, however, to applying their work in the field of veterinary science.

"If you have say 2000 battery laying hens, they are prone to infection from various sorts of pathogens and have to be injected with vaccines on a regular basis.

"Putting the vaccine into the water supply is unreliable but we (could) condition the birds to a certain flavor in the watering system so that the birds' immunity would be boosted when they tasted it."

Paralysed scientists feel breathless

What some people will do to prove a point! A team of University of New South Wales scientists have resolved a scientific controversy by totally paralysing themselves while remaining fully conscious. At issue was how the body controls breathing and what causes the feeling of breathlessness. Three of the team were injected with a drug at a dose five times greater than for surgical paralysis while being kept alive on a ventilator. When higher levels of CO₂ were introduced into their air supply, the subjects reported feelings of breathlessness, proving that the sensation is triggered by a sensor in the brain and not by contraction of the breathing muscles as had been commonly argued. The subiects communicated their responses by moving the fingers of one hand which had been kept free of the drug by a tourniquet.

Fungus cleans soil of toxins

A US research team has found a fungus that eats creosote and other toxins. Soil contaminated with toxic products of a wood preservative factory (creosote and the wood preservative, pentachlorophenol) was treated with the lignin-degrading fungi, Phanerochaete sordida - a naturally occurring fungus. After eight weeks of the fungus growing in the soil, 89% of the pentachlorophenol and 75% of the creosote had been removed.

Murdoch to be base for UN solar research

Murdoch University is to be headquarters of the United Nations Industrial Development Organisation (UNIDO) solar research centre. The Centre for Applications of Solar Energy (CASE) will be Australia's first United Nations research centre and is expected to attract business worth \$30 million to Western Australia over the next five years.

Hammerhead ribozyme patent awarded to CSIRO team

A CSIRO research team has been granted a US patent covering hammerhead ribozyme technology. The broad patent is the first ever to be granted for the general structure of this most widely used form of ribozyme.

Ribozymes are RNA molecules with enzymatic activity. They provide a way to selectively interrupt the operation of genes by cutting the messenger RNA (mRNA) molecules produced by the gene action — a potentially powerful tool that can be directed against viruses or genes with harmful characteristics.

Gene Shears Pty Ltd of Sydney, Australia, holds the exclusive worldwide licence to these ribozymes and their commercial applications. Established in 1989, Gene Shears raised over \$US 20 million in its first round of financing. Its shareholders are Johnson & Johnson, Groupe Limagrain and CSIRO.

Science in the media

Steve Utick

recent study has revealed that throughout the national print media, science had consistently increased (often doubling) its share of the news published. In newspapers the average share of science news rose from 2.1% in 1989 to 2.9% in 1993. The business press is taking science and innovation more seriously and television news is improving, particularly on the Nine network. Radio, outside the ABC, is a wasteland with science coverage by commercial radio halving since 1989.

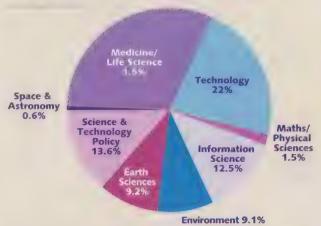
The study, conducted by the Department of Industry. Technology and Regional Development (DITARD) found that most papers offered less science and technology articles per issue but published larger feature articles more frequently. Medicine and life science remain the most frequently covered science fields in all media and are featured in the most depth. Technology (including agricultural technology) comes second in newspapers and now leads in general magazines. Science policy and computers also have established niches in newspapers, and science policy is well covered in the electronic media. In all media, maths and the physical sciences (physics and chemistry) continue to be poorly covered.

Over 80% of all science and technology news on radio is broadcast on ABC stations (compared with 44% in 1989), with commercial stations offering half that of the equivalent period in 1989. Most commercial stations now cater for niche markets, particularly on FM bands, and are music oriented, hence the silence on science.



Change in share of science and technology news as share of total content in Australian print media, 1989 to 1993.

Coverage of science and technology has increased.



Science in Australian newspapers, 1993. Medicine and life sciences received the most coverage while maths and physical sciences were less than 2% of the total.

Television news offered a positive contrast: there was an across-the-board improvement for all networks in Victoria and Queensland between 1989 and 1993, with science and technology coverage now comprising 1% to 5% of television news and the Nine network recording a creditable 6% or more in both Sydney and Melbourne. Melbourne now has better science and technology coverage on television news than Sydney.

Science topics occasionally crop up on current affairs programs — ABC's Lateline, Seven's Real Life and Eleven

AM, Nine's Nightline and Today averaged two to three minutes of science coverage per program. Nine's business-oriented Sunday and ABC's rural program Landline provided solid offerings of 10 minutes per program.

Just how much of the scientific information available in the media is readily accessible to women and young people? National newspaper and business magazines are covering more science and technology, but women's Australia-wide readership share of these publications is 40% or less. However, women make up

nearly half the readership of the Weekend Australian, a paper which offers a solid 5% coverage of science, and of the major metropolitan dailies. Women also comprise 70% or more of readership of the lifestyle magazines, from which they can pick up additional medicine and life science news, though not much computer and technology news. In the electronic media, men and women watch television news in more or less equal proportions.

Fourteen to 17 year olds have a low readership of those newspapers with a high percentage of science coverage, and get more than their share of news from women's magazines. (Because at least twice as many girls as boys read the likes of Cleo and Cosmopolitan, they may have better access to medicine and life science information.) Radio, particularly on the FM bands so popular with youth, offers very little in the way of science and technology news, but television news is a significant source of science information for this age group.

Access to science and technology news in print is not a problem for those aged 18 to 24, who maintain their population share or better in readership of all print media. However, they watch less television news than younger teens.

It is worth noting that women and young people may find the accessibility of scientific information affected by the media's presentation of science as a male occupation. In the 1993 survey, a woman's voice was heard in only 20% of instances when a scientist was interviewed in the electronic media, and in 64% of these, the voice was probably that of a female doctor!



Mystery catalyst may protect against oil spills



Clean up of the Exxon Valdez oil spill in 1989. The giant super tanker went off course in Prince William Sound near Valdez and hit submerged rocks. The spill, 42 million litres of oil, is known to have caused the death of 580,000 birds, 5500 sea otters, 30 seals, 22 whales and unknown numbers of fish and oiled 5100 kilometres of coastline. Total cost of the accident including clean up and legal settlements has been estimated at \$US 4 billion.

David Eyre

University of South Australia research scientist, Dr Jani Matisons, has found a catalyst which turns oil to gel in seconds, preventing it from spreading. The discovery has major implications for environmental protection and the oil industry.

Tests have confirmed that the catalyst can absorb 30 times its own weight, trapping and containing oil in a rubbery gel. If the same result can be achieved on a large scale, oil spilt from tankers could be turned into large floating lumps, harmless to marine life and easy to collect. The jellified lumps may then be reprocessed and most of the oil recovered.

The catalyst jellifies a

range of organic compounds besides oil, reduces volatility and risk of fire and has many possible applications including controlling impacts of chemical storage and road tanker accidents. Its chemical composition is a closely guarded secret pending the granting of an international patent.

Matisons says that the catalyst's 30:1 gelling ratio defies current chemical understanding, as its molecule traps far more oil molecules than it has binding sites. "It doesn't make sense – it could work like a three dimensional net,

but its 'meshes' seem too large to trap as many oil molecules as it does." He is seeking federal funding to do the core research necessary to understand the effect. Meanwhile, negotiations are being conducted with industrial heavyweights to develop specific applications under licence.

"The university hasn't got the impetus or the funds to drive this at the correct level, which is global," says Matisons.

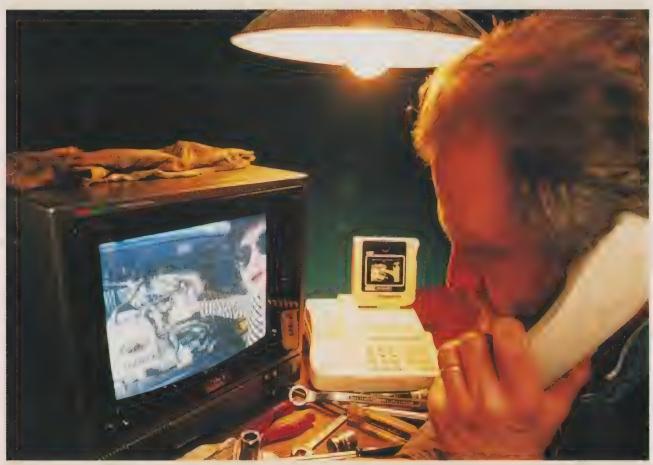
He is optimistic that funding from industry will allow a full-scale trial of a specific application of the catalyst within a year.

within a year.

Dr Jani Matisons with a cake of jellified oil – a major breakthrough in pollution control.



Look who's talking: videophones Australian debut



Kent Wildish

The videophone era has begun. After decades of waiting, the first domestic videophones are already operating in the US (made by AT&T or MCI) and a GEC Marconi product, seemingly identical to the MCI videophone, was released in the UK this year. The GEC Marconi product will be released in Australia in 1994 under the Telecom Australia badge 'Videofone 2000'.

What is it like, and who will use it? In a nutshell, it's sleek, sexy and expensive. With a price tag of \$1200, it is likely to enter the market as an accessory for the rich or those with special needs.

But what if you don't

want to be seen? With the Videofone 2000, video connection is established after audio connection, by mutual agreement of both parties. This should alleviate fears of being caught coming out of the shower and preserve privacy with regard to emergency calls, unsolicited ads and obscene phone calls.

The privacy option arose after users in an early trial in Mitaka, Japan, found videophones intrusive because it was impossible to turn the camera off. Users were highly inventive in solving the problems of videophone etiquette. Some placed a poster or photograph in the line of vision of the videophone camera and removed it only when they had established that the caller

was a friend; another group of users reached an agreement that they would always call each other on the conventional telephone before putting through a call on the videophone.

The almost unique blend of anonymity and intimacy offered by conventional telephone communication has had interesting social results. Although it was difficult at first for users to speak to people they couldn't see, telephone skills and protocol were gradually developed. We evolved new forms of greeting ('hello' came into the language as a phone greeting), new styles of address ('the phone voice') and a myriad of phone behaviors that are now so habitual that we take them The big benefits will come when videophones go mobile: a mechanic making a remote diagnosis.

for granted. According to Dr Larry Cromwell, anthropologist and communications analyst, "we now have more fights on the phone than anywhere else".

The development of new social etiquette for the videophone will take time, but we can expect the new technology to have significant impacts on the way we live and communicate.

Telecom's Videofone 2000 will delight many customers but may, in the early days, disappoint some. Operating over the existing phone network,



ISDN - bridging the video gap?

Business users unsatisfied with the image quality of videophones operating on the standard network and impatient for the arrival of a widespread optical fibre network (still decades away) are likely to take advantage of the capabilities of the Integrated Services Digital Network (ISDN).

ISDN sends digital signals over dedicated wire links. With data rates of 128 kb/s or 10 Mb/s, compared to the 19.2 kb/s rate of typical phone lines, ISDN facilitates and integrates high-definition video, data, Group 4 (digital) fax and voice transmissions.

Australians are in the box seat to take advantage of ISDN. Where engineers in

other countries are being hampered by incompatible standards and equipment amongst their various carriers, standardised Telecom exchange equipment has resulted in Australia becoming the first country in the world to have a nationwide ISDN service.

What's more, Australia has chaired the international committee that is developing world-

wide standards for ISDN — due in part to our national reputation for impartially evaluating and modifying equipment from other nations.

Because we're not seen to be aligned with any of the



major manufacturing blocks (Europe, USA, and Japan) and are actively involved in setting standards, local ISDN equipment manufacturers are set to carve out a handy niche market. Some, like Sydney's Jtec Pty Ltd, are starting to

The Telecom Videofone 2000, due for release in 1994.

receive substantial export orders for ISDN multiplexers and other equipment.

Manufacturers in other countries have already begun to produce ISDN videophones. A Hitachi model, the HV 100, is currently being evaluated in Australia. It has a screen around the same size as the Videofone 2000 (pictured) although with more satisfactory frame rate and resolution. With a price tag well into the thousands, plus high line-rental costs, the ISDN option faces barriers to domestic acceptance.

video transmission stretches current digital compression techniques to the limit. The picture is displayed on a matchbox-sized screen, and the video frame rate is five frames a second - around a sixth of the frame rate needed for full motion video. The result is not so much 'video' as 'stutter vision' - a series of low-resolution stills. (ISDN lines allow better quality video. See box for details on Australia's role in ISDN technology for videophones.)

Historically, videophone services have suffered from premature release and unrealistic expectations. The first 'picturephone', combining television and telephone, was demonstrated in the US as early as 1927. The first public service, between Berlin and Leipzig, operated briefly in 1936.

Enthusiasts foresaw businesspeople travelling electronically rather than physically, with consequent increases in productivity, and reductions in travel expenses. In 1969, analysts forecast there would be three million picture telephones in use in the US by 1985

It hasn't happened vet. Steven Schnaars, Associate Professor of Marketing at Baruch College, City University of New York, gives two reasons. Firstly, the services offered have been expensive. Secondly, the commercial need was low. In situations where personal contact is crucial, seeing people over the phone is a poor substitute for meeting them in person -"pressing the flesh proved insurmountably superior to pressing buttons".

The videophone may face other hurdles. To make a videophone call, both parties need compatible equipment. In the US, the MCI and AT&T

products don't talk to each other. Even the proposal by Telecom Australia to market pairs of compatible Videofones (one here, the other in the home of a relative or loved one overseas) may not be enough to launch videophones on a wide scale. Electronics consumers haven't forgotten the VHS vs Beta VCR standards war.

To be widely accepted, videophones will need higher-resolution, full-motion, bigger screens, portability, compatibility and a lower price. At this time, the first two would seem to depend largely on the installation of optical fibre networks serving the home, but breakthroughs in satellite technology and digital radio may soon change this.

A satellite consultant to Hughes Space and Communications Co has leaked plans to develop a low-cost videophone able to send fullmotion, big-screen pictures. Video camera signals will be sent via satellite and displayed on standard TV sets. Sending and receiving, however, would require a bulky dish antenna, 60 cm wide. Hughes Space and Communications is reportedly delaying a formal public announcement about this until the US Federal Communications Commission has seen its application for the service.

Portability could mean videophone users won't be tied to a terminal for a head-and-shoulders shot, and has potential to transform the way we handle situations where visual feedback is required between remote locations – for example, product demonstrations, and medical and police emergencies. At this stage, portability awaits developments in digital radio and 'low Earth orbit' satellites.

MIRA - Art on-line

Brett Wright

one of the world's great art galleries, the National Gallery of Art, Washington DC, is planning to use digital technology to make its collection available to art lovers, researchers and students throughout the world.

The gallery – which houses some 80,000 objects – has teamed up with IBM to develop a system for storing in a digital form high-resolution, 'faithful' color photographs of paintings and prints for distribution on computer networks and CD-ROM compact disks.

Ultimately, its designers hope the system – known as MIRA (Spanish for 'look with wonder') – will "erase the physical boundaries of the collection" and make art much more accessible to schools, universities and libraries.

The MIRA system was demonstrated in Australia for the first time at a science conference held last month at the Scienceworks museum in Melbourne.

Recent research by IBM and the National Gallery suggests that the public (in the US and internationally) has access to only two per cent of the knowledge and artifacts held in the world's galleries, museums and educational institutions. Almost all of these collections are out of reach of the average student due to "the sheer size of the collections" and limitations on space for public viewing.

Under MIRA, a user will be able to search a database to determine which objects or paintings are needed, and then retrieve the images from either a CD-ROM or via a Local Area Network from an optical storage library. A



Erasing the physical boundaries of collection: a high-resolution computer image of Bellini's 'Feast of the Gods', courtesy of Washington's National Gallery of Art.

retrieved image can be displayed, edited or printed in a widely-used file format for computer graphics.

The MIRA software – which is designed to run on personal computers using IBM's OS/2 operating system – allows the user to choose the level of resolution desired, from low-resolution 'thumbnail'-type images to 'faithful' 24-bit color images.

At the highest resolution available, a single painting would contain as much as 40 million bytes of digital information.

According to Ric Snyder, assistant treasurer at the National Gallery, a high-resolution MIRA image of a painting contains more detail than a visitor would obtain from going to the gallery and looking at the painting itself. "You wouldn't be able to get close enough to the picture," he said.

IBM plans to begin production of the new system by early next year.

Greener pastures for Fairfield Hospital

Just two years ago, Melbourne's Fairfield Hospital was under threat of closure. Now it is a market leader. The hospital has substantially reduced its labor force (30% over the last two years) while increasing both patient throughput and the range of clinical services and community outreach programs offered.

Fairfield has established 'business units' which sustain their own support staff and services, relieving pressure on diminishing government grants. The hospital's Executive Director, Mr Chris Richards, said that this change in philosophy has positioned Fairfield to take advantage of niche markets for which existing services can be readily adapted to develop new revenue supported services.

Richards says it is the range and diversity of services offered which sets Fairfield Hospital apart from others in the field. "Traditional work methods are being revised to make room for global networking between departments,

consolidating and improving in-house expertise."

The Fairfield Campus Information Network (FCIN) allows subscribers to access the hospital's information resources, servicing both hospital staff and an external client base of subscribing hospitals, community health centres, libraries, pharmacies and general medical practitioners. The hospital also offers a 0055 'Travel Health' recorded advice service (15676) providing information to prospective and returning travellers on such matters as malaria, hepatitis, tuberculosis and influenza.

Another important service provided by the hospital is the environmentally efficient disposal of biomedical waste. The Fairfield incineration facility now incorporates a state-of-the art rotary kiln, and the hospital plans to use the heat from burning waste to generate electricity in the near future.

Fairfield has also become the home for a number of other agencies, including the National Centre for Health Program Evaluation, the MacFarlane Burnet Centre for Medical Research, and the Australian Institute for Environmental Health (Victorian Branch). Collaborative links with and between these agencies help promote Fairfield's evolution into a comprehensive public health campus providing a wide range of services for the benefit of the community.

As Louise Lyons, Director of the Centre for Health Information Technology, says, "more really can be done with less if you are willing to think laterally and make use of available technology to meet the needs of the community, and consider the potential market as lying outside the grounds of the hospital".

Apocalypse?

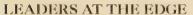
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Catching genes in the screen

Genetic screening for diseases such as cystic fibrosis is clearly a beneficial application of a powerful technology, but who should be allowed to use or read your genetic print-out? Robyn Williams spoke to Dr Bernard Dixon, a microbiologist and previous editor of New Scientist, following a major conference in the UK on genes, gene conservation and genetic screening.

What's your position these days?

Bernard Dixon: I am editor of *Medical Science Research* – I do lots of other things but that should suffice.

We are talking about the Birmingham Genetics Conference. What was special about it?

The convention happened to take place two or three weeks after the announcement of the alleged gene for homosexuality, and this was something that was very much discussed on the agenda. There was a very useful corrective, a critique in other words, of that paper, which can be interpreted in a very simplistic way to say, here is a gene. If you've got it, you become homosexual. If you don't get it, you are not liable to become homosexual. This is, of course, a gross simplification. This was criticised scientifically in terms of the methods the workers used in producing the results, but also from a social and political perspective, and people were (initially) worried, but (subsequently) reassured that we are not simply prisoners of our genes. Predestination by our genes is something which does of course occur with some classical black-and-white diseases like haemophilia, but on the whole that's not what happens. What happens is genes interact with environment, with our diet, our nutrition, our behavior, with all sorts of other things. There is a very healthy, I think, and broad-ranging discussion of that.

So if it's not a gene for gayness, what is it?

I think it is not surprising there may be a gene, and I think that even the authors

themselves are very cautious about this, but there may be a gene which does help to predispose people to become homosexual. But that's very far away from saying that this gene makes you into a homosexual, and if you look at the actual paper, which wasn't always reported as clearly as it should have been, this was a study restricted entirely to people who declare themselves as homosexual. In other words, it wasn't even typical of the homosexual community at large. It also excluded women. It excluded heterosexuals. It was a very, very narrow, focused study which seemed to suggest that there might be some sort of genetic predisposition, but with those qualifications and others, I don't think one could say any more than

As I remember, that was published in the journal *Science* a few weeks ago, and people had discussed the possibility, and this is more than just gayness, of having a kind of audit of the genes of a baby about to be born, or even when it is a fetus, so that in some future time the parents can choose to have it aborted or not, depending on whether it measures up. Was that discussed much?

Oh yes, and even going past the question of what is called therapeutic abortion to what is now being developed and has now been used in London, which is pre-implantation diagnosis, whereby doctors can now screen an early fetus and look for a particular disease-causing gene and re-implant in the women a fetus that is not carrying that gene. Using that technology you can

now be sure, for example, that you are not going to re-implant a fetus carrying the gene for cystic fibrosis, which is a horrendous disease. That technology is now with us, and is going to become available widely throughout the world in the next five or 10 years.

What about the question of taking it much further? For example, people in the future perhaps will be concerned that scientists will get hold of their DNA, and insurers, employers and various other people will say 'OK, convince me that you are clean. You don't have to, but if you don't present us with the fact that you won't have schizophrenia or alcoholism when you are 50 or 45 or whatever, we have plenty of other people to choose from'. Again, undoubtedly, it is going to be with us. I think this is the central issue here, that there - you mention alcoholism - have been claims of genes predetermining alcohol dependency. Those claims are not yet vindicated, but again it is not unlikely there are such genes and that we will be able to have that information. I think there are a number of levels here after all. One is information which is useful to you or useful to parents regarding their children. If for example they can be told at an early stage their child is, say 5000 or 10,000 times more likely than the average child to develop skin cancer because of a genetic predisposition, then that family may well decide to move from a sunny climate to a climate which is rather dull, thereby reducing the likelihood of external factors, environmental factors (in this case sunlight), switching



"Predestination by our genes is something which does of course occur ... but on the whole what happens is genes interact with environment, with our diet, our nutrition, our behavior, with all sorts of other things."

on that gene. Because that is essentially what happens – your environmental factors, even smoking, produce lung cancer because (they are) switching on a gene which produces lung cancer. So that is information which is of great personal use and of value.

The next level would be screening for employment, which is a very tricky question. It is a two-edged argument here. Clearly it is sensible that people with haemophilia would be well advised not to become butchers. That's obviously an extreme example. On the other hand, what about some environmental pollutant that you might encounter in a chemical factory to which some of us may be predisposed? Is it discriminatory or is it simply common sense to actually screen people and eliminate those from the workforce? That's an argument that's by no means resolved yet.

Screening for particular diseases can, on the one hand, be wholly beneficial – I mentioned cystic fibrosis. On the other hand, there have been cases – a few years ago, for example, in Sweden

- where screening was by no means wholly beneficial. It caused problems, and this was in relation to something called Alpha-1 anti-trypsin deficiency, which is a condition which some people are predisposed to and which makes you more likely to develop emphysema if you smoke, for example, or if you are exposed to something in the atmosphere through atmospheric pollution. Well, a few years ago in Sweden, a study was established in which children were identified as having this deficiency, and this led to their parents being urged to urge the children in turn not to smoke. All that happened was that it caused a lot of trouble between parents and children; it underlined what's always there in adolescents anyway - a certain degree of antagonism between children and their parents is natural, but this made it a good deal worse without any great benefits, and the project was abandoned. So there's an example where screening was by no means wholly beneficial.

You then come to the issue of screen-

ing in relation to insurance, and this was talked about in Birmingham but was by no means resolved. I don't think even the insurance industry itself has fully recognised the power of the information that is going to become available, and what we are talking about eventually here is the ownership of information. Max Perutz, Nobel Laureate, in his opening address, said the only principle here is that an individual should be the owner, and have access to that information. But it is very hard to see how that can be applied in practice if insurance companies, knowing that a particular test is available which might be helpful today, can insist that people take that test, or make that information available, or make you open to a penalty if you haven't disclosed that information. It's going to be a great problem over the next five or 10 years because, really, the technology is upon us.

And indeed, it is very easy to get hold of people's cells. I mean, you are giving blood all the time, you are being tested all the time, and it's just like somebody getting hold of your credit card number. You don't know quite where it can end up.

That's quite right, and of course there have been cases where blood samples have been screened not for genes but for evidence of, say, syphilitic infection or AIDS. There have been many examples where blood has been screened without the patient's knowledge for what were considered to be beneficial purposes. Take that to the level of the gene and, yes, once you have mapped a gene, then the technology of actually screening for that gene is very simple. It is not high-cost science at all. It's very cheap, and that's a worry.

Those are some of the worries that came out of Birmingham, but what about the positive side? What was the good news?

The good news? Well there's loads of good news coming all the time. Hardly a week goes by without some gene being isolated which is responsible for some condition, and as I said, that can lead on to making use of that information in beneficial ways. One of the perhaps unexpected issues that came out of the meeting, which we have all heard about but which really was focused rather sharply by a slightly odd example, is the need for conservation of genetic resources. We are talking here particularly about plants - species of plants going out of existence, becoming extinct virtually every day in particular habitats such as rainforests and so forth. Now, we've all heard about this but it was actually focused in a sharp way by speakers who gave a number of very clear examples.

A Peruvian speaker, Dr Carlos Arbisu, talked about an anti-aphrodisiac which is a substance extracted from a plant in Peru and which traditionally was given to armies on the march to keep them quiet – and which is given to this day. The plant is collected and prepared by women in certain parts of



"I don't think even the insurance industry itself has fully recognised the power of the information that is going to become available, and what we are talking about eventually here is use, ownership of information."

Peru to give to their husbands if they are going away on a long journey. It does work, apparently. The substance has been isolated and characterised. It's an alkaloid and we know what it is, and so it has become real science, as opposed to traditional herbalism. But somehow, this particular example focused attention on the very issue of conservation of plants and genetic resources. In other words, we're not just talking here about the importance of conserving maize or wheat or other cereals because we may need germ plasma to breed future crops or for transferring genes from one to the other. We are talking about a whole range of biologically active substances with medical or veterinary or other uses which are being produced already in quantity by plants, many of which we don't even know exist and (which) have never been studied.

In the 30 seconds that's left – having had this gigantic conference of scientists – does it work having the public involved like that?

It worked beyond our wildest expectations. There were at least 400 people, members of the public, coming in to every one of, I think, eight or nine sessions we had, with a corresponding number of congress delegates, and they were able to exchange views. (There was) a lot of time for discussion and debate. This has never been done before. It worked extremely well. Everybody was saying so. We would hope in fact that this would become a model for other scientific meetings in future. Why confine discussion about science to scientists behind effectively closed doors? No, I think this is - we hope it will become - a model for scientific congresses in future.



Sustainable development

If the human race is to survive, with all of Earth's biological variety and richness, we must embrace sustainable development – the only path to the future. In the following 52 pages a variety of authors discuss greening the blue planet, with specific focus on this wide brown land.

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Tough choices bedevil sustainable development

Can we preserve the environment and maintain our lifestyle without radical change? Technological fixes within the context of 'business-as-usual' cannot solve our critical environmental problems. Sustainable development may only be possible if we are prepared to change the structure of society – and accept that the environment is irreplaceable.

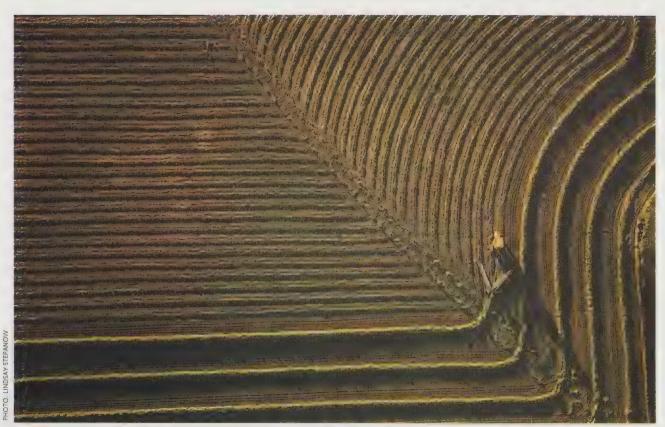
HE CONCEPT OF SUSTAINABLE development has succeeded in gaining widespread support among the world's decision-makers and power-brokers because it aims to protect the environment without the need for radical change. It sets out to make necessary modifications that will enable normal economic activities to be sustainable into the future. At the same time, it recognises that serious and irreversible environmental degradation should be prevented because it could diminish the ability of the planet to sustain such activities.

Industry groups and business associations have produced numerous documents and policy statements on sustainable development outlining how the environment can be protected in a context of economic growth, freed-up markets and industrial self-regulation. But the support of environmentalists for the concept of sustainable development has been less universal.

While some welcome the newfound attention being paid to environmental protection and the opportunity to negotiate with governments and developers on these issues, others are more wary of the minimalist approach that seems to be inherent in the sustainable development approach. They argue that more fundamental institutional and social changes need to take place, including a shift towards steady-state economies.

Sustainable development seeks to change the nature of economic growth rather than limit it, and at the heart of the debate over its potential effectiveness is the question of whether technological change can reduce the impact of economic development sufficiently to ensure that other actions will not be necessary. The other actions include changes in population growth and consumption levels, two items which appear to have slipped from the agenda since nations were unable to come to any agreement on them at the Earth Summit in Rio de Janeiro in June 1992. If environmental impact is a function of numbers of people (population), resource use per person (consumption), and environmental impact per unit of resource used (technology), this leaves technology as the remaining variable available for manipulation.

Can technology give us environmental protection and



"Having the technological means to protect the environment does not mean that it will automatically be used. Yet if technology is socially shaped, can we achieve radical technological change without equally radical social change taking place?"

economic development? Can it ensure equity between and within generations so that everyone, now and in the future, our far neighbours and our great-grandchildren, can enjoy the standard of living we do? Such an accomplishment would require more than just a few adjustments to existing technological systems. It would require a radically different technology. Yet if technology is socially shaped, can we achieve radical technological change without equally radical social change taking place?

Attempts to invent and design more environmentally sound technology are not new. The Appropriate Technology Movement, which blossomed in the 1970s, attempted to do just this, and today involves an extensive network of groups, its own literature and numerous demonstrated technological innovations. Despite this, it has failed to influence the pattern of technology choice exercised by mainstream society.

Many of the advocates of appropriate technologies made no attempt to understand how modern technologies were developed and why they had been accepted or alternatives discarded. It is important not to put too much emphasis on technology without considering the social, political and economic factors that can be crucial in the shaping and implementation of technologies. It seems that those pinning their hopes on technology to deliver to us a sustainable future may well be doing the same thing as the Appropriate Technology Movement before them. Having the technological means to reduce pollution and to protect the environment does not mean it will automatically be used.

CCORDING TO PATRICK MCCULLY, writing in *The Ecologist:* "The reason that the USA is the most polluting nation in the world has little to do with a lack of energy efficient technologies or renewable methods of producing electricity: it has a lot to do with the size of the country's oil, coal and automobile industries, and the influence they have on the political establishment. In the UK, the public transport system is expensive, unreliable and infrequent, not because the government cannot afford to improve



"Efforts to clean up the environment have tended to concentrate on technologies that are added to existing production processes to control and reduce pollution, rather than changes to the production processes themselves."

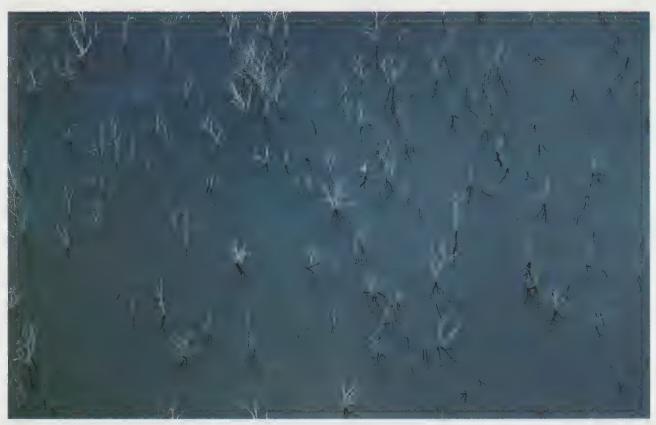
it or does not know how, but because the vested interests behind public transport have negligible power compared to the influential road and car lobbies" (McCully, 1991).

Given that there are many environmentally beneficial technologies already designed and available for implementation, there is a need to look beyond the designer of technology to other people in society who affect decisions about technological choice, including businesses, governments and consumers.

At the Earth Summit, the governments of 170 nations signed Agenda 21, an action plan for sustainable development which said: "the policies and operations of business and industry, including transnational corporations, can play a major role in reducing impacts on resource use and the environment".

Yet although the burden of technological change seems to lie with business and industry, many firms are not implementing environmentally beneficial technologies, despite their availability. The Australian Government's ESD Working Group on Manufacturing found that firms did not "appear to have made full use of available technology and management with respect to energy efficiency", and that "in many industries a range of technologies for green products and cleaner production are already available but have not been generally adopted".

OREOVER, EFFORTS TO clean up the environment have tended to concentrate on technologies that are added to existing production processes to control and reduce pollution rather than changes to the production processes themselves. The alternative to these end-of-pipe technologies is to adopt new 'clean' technologies that alter production processes, inputs to the process, and products themselves, so that they are more environmentally benign. The Dutch researchers Cramer and Zegveld (1991) advocate process technologies that require less water (for example, by alternative drying techniques), energy and raw materials, and reduce waste discharges (for example, by developing detection and separation machinery and process-integrated flue-gas cleaning). Raw material inputs and processes can be changed so



"While consumers may influence packaging and some ingredients of products, they are usually unable to influence more hidden aspects of a product, such as how it is manufactured or whether it's distributed by road or rail."

that, for instance, solvent-free inks and paints and heavy metal-free pigments are used. The end products can also be redesigned to reduce environmental damage during both manufacture and use, and waste flows re-used within the production process rather than dumped.

Clean technologies are preferable to end-of-pipe technologies because they avoid the need to extract and concentrate toxic material from the waste stream and deal with it.

Yet cleaner technologies are not always available, and even when they are, companies tend not to replace their old technologies until they have run their useful life. Firms prefer to keep to a minimum the organisational changes that need to be made; they like to play it safe when it comes to investment in pollution management. The ESD Working Group on Manufacturing commented: "It is apparent that in many cases end-of-pipe technologies are readily available, easier to adopt and more evident as anti-pollution measures than clean production processes".

A series of media reports and books, such as The Green

Consumer Guide (Elkington and Hailes 1989), have given many people the impression that the environment can be saved if individuals are responsible in their shopping habits and buy only environmentally sound products. The idea is that firms wanting to take advantage of this new demand for green products will change their production processes and redesign their products to meet the demand. Environmentally sound goods will become profitable. This view has been reinforced by David Pearce, director of the London Environmental Economic Centre, and his colleagues, who stated that "sustainable development means a change in consumption patterns towards environmentally more benign products, and a change in investment patterns towards augmenting environmental capital" (Pearce, Markandya and Barbier, 1989).

The tendency for consumers to prefer environmentally sound products has already become evident. Market research shows that in Australia and other high-income countries, a significant proportion of consumers (though by no means the majority) make an effort to buy green products such as pump

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packs, unbleached papers and items made of recycled paper. A survey commissioned by Clemenger/BBDO in 1990 found that about 28% would pay more for safe aerosols and biodegradable plastic products, and 35% would pay more for natural foods that were produced without pesticides.

Suppliers and users can also influence firms through their purchasing or product stewardship policies. Some companies are already introducing systematic environmental purchasing policies, and some are making specific demands on their suppliers for products, such as plastics without PVC or plastics that can be recycled more easily.

Marketing managers who recognise new opportunities in the growth of green consumerism can encourage their firms to invest in 'clean' technology and then market their products on that basis. They can also convey to their firms the potential for environmentally damaging activities or discharges to receive adverse publicity (Schot, 1992). Such ideas have already prompted a surge of advertisements and labels claiming environmental benefits. Green imagery is used to sell products and caring for the environment has become a marketing strategy.

However, the power of consumers to influence technologies is limited. Often their information is confined to advertising claims that might be misleading or insubstantial. Greenpeace campaigners Dadd and Carothers (1990) claim that Chevron, a multinational oil company, spends about five times as much publicising its environmental actions as it does on the actions themselves. Nor does the consumer face clearcut choices. Green consumers tend to prefer natural fibres to synthetics, but the cotton industry and large-scale sheep grazing cause significant environmental damage. The debates over whether plastic packaging is better or worse than paper packaging for the environment, or whether milk bottles are better than cartons, are sure to confuse consumers.

HE ESD WORKING GROUP on Manufacturing points out that any judgement about whether a product is ecologically sustainable is extremely complex, requiring long-term assessment from manufacture to disposal and taking into consideration how long the product will last, whether it can be reused or recycled, whether it is biodegradable, how much energy it consumes and how efficiently it uses resources. Other matters that need to be considered include the way the product will be used, transported, distributed, marketed and packaged.

According to Dadd and Carothers, the products available to consumers do not necessarily reflect consumer demand. If it is cheaper for a company not to recycle bottles, then it will not.

They say car companies push "big cars with high compression, high-pollution engines on the American public" because they get the biggest profit from them, not because the public demands them. US scholar Patricia Hynes (1991) claims organic food products make up only 4% of the US food market, although demand would easily reach 5% to 10%. She argues government policies prevent farmers from giving up methods of farming that are highly dependent on agricultural chemicals.

While consumers may influence packaging and some ingredients of products, they are usually unable to influence more hidden aspects of a product, such as how it is manufactured or whether it's distributed by road or rail.

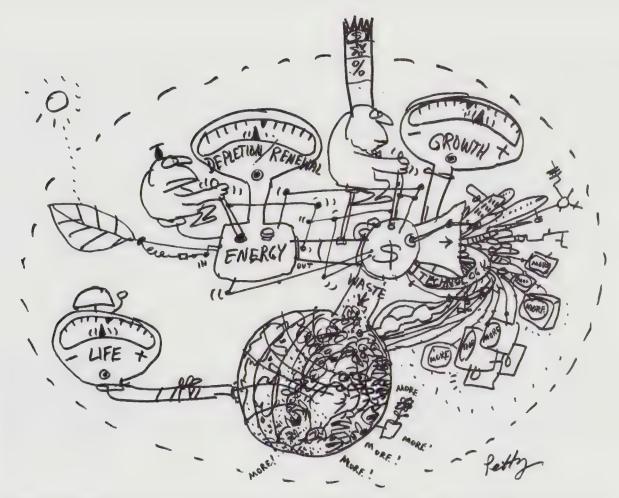
Governments are in a much better position than consumers to influence such decisions, through a variety of mechanisms. They can reinforce the role of the consumer, through provision of information about the health and environmental impacts of products and production methods and by preventing false advertising. They can also encourage the development of new technologies, by funding or subsidising research and development.

Governments tend not to be very good at translating government-financed inventions into commercial successes. Nor does subsidising firms to make changes for environmental protection purposes appear to have been very successful. Experience in the Netherlands between 1975 and 1990 showed that subsidies were not usually spent on clean technologies but instead went to larger firms that would have made the required investments anyway. Moreover, subsidies have tended to lead to the development of end-of-pipe technologies, rather than changing the direction of the technologies being developed.

Governments can encourage the development and implementation of clean technologies through the use of laws and regulations which cannot be met without technological change, or through the use of economic instruments meant to provide a financial incentive for technological change.

A number of studies have shown that environmental legislation can be a key factor in many industry innovations. A study of 164 innovations in Europe and Japan found that regulations (mainly environmental and safety) not only promoted innovation, but were a factor in the success of these innovations, particularly in the chemical and automobile industries (Royston, 1982). This was because the technology for meeting the regulations was often readily available; it had not been implemented because company engineers had other priorities. Government regulations had forced a reordering of priorities, allowing technological changes to take place fairly quickly and environmental and safety improvements to follow.

However, regulation seldom leads to the development of



"Because of the reluctance of governments to act against the interests of business, legislation and economic instruments are seldom tough enough to foster technological change of the type required for ecological sustainability."

radically different technologies, but rather to technologies closely related to those already being used. Laws and regulations tend to lead to end-of-pipe technologies because they are usually too weak and are aimed at quick remedies to severe environmental problems. In order for them to affect the original design and shape of a technology, they need to be very stringent – so stringent that existing technology will not suffice. They also need to be introduced progressively, so that a firm can anticipate what will be required and have time to develop innovations.

ILLUSTRATION BRUCE PETTY

In some cases in the USA, standards have been set on the basis of environmental or health requirements rather than on the basis of available technologies. This has resulted in new technologies being developed and implemented. Lawsuits, regulations and the threatened ban on PCBs forced PCB users to develop product alternatives. Most of these substitutes were

cheaper than the PCBs they replaced. Bans on CFCs in aerosols resulted in two innovations: a non-fluorocarbon propellant which uses carbon dioxide, and a new, cheap pumping system that did not depend on propellants.

Proposed pre-treatment standards for wastewater from the electroplating industry were predicted to force a closure of 20% of electroplating workshops. A research and development project that followed the announced proposals produced a new rinsing method which reduced water consumption by one-third and cut hazardous waste production by 50% to 70% (Caldart and Ryan, 1985).

These cases show that regulatory constraints are not necessarily detrimental to the viability of the industries being regulated.

Economic instruments seek to encourage technological change by providing a financial incentive for firms to direct

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their research and development towards environmentally sound technology. However, like legislative instruments, economic instruments have tended to be too weak to achieve any real technological change. The OECD (1989) has found that in most cases charges are too low to provide such an incentive, and merely act to redistribute money from the polluter to the government. Similarly, tradeable pollution rights have been found to save money for industry but do not improve environmental quality significantly.

Because of the reluctance of governments to act against the interests of business, legislation and economic instruments are seldom tough enough to foster technological change of the type required for ecological sustainability. Although such regulation would probably strengthen business in the long run, business people see strong government intervention as an infringement on their autonomy. Barry Commoner, a well-known US environmentalist, argues that business people are supported in this because there remains a strong public conviction "that the decisions that determine what is produced, and by what technological means, ought to remain in private, corporate hands" (1990).

Sustainable development relies on technological change to achieve its aims, but will governments take the tough steps that are required to force radical technological innovation rather than the technological fixes that have been evident to date? Such measures would require a long-term view and a preparedness to bear short-term economic costs while industry readjusts. It is hard to see governments being willing to do this in today's socio-economic climate in Australia. David Dickson, a well-known writer on technology and former editor of *New Scientist*, has pointed out that an alternative technology can "only be successfully applied on a large scale once an alternative form of society" has been created.

VEN IF CLEANER TECHNOLOGY were implemented, would the reductions in pollution be enough? Cramer and Zegveld claim they would not, if production continues to grow. In the Netherlands, where the purchasing power of the average person is expected to increase by 70% by the year 2010, they argue that "an incredible reduction in discharge levels and waste flows per product unit would have to be realised to achieve the aim of a sustainable society" (1991). On top of this, production would need to increase 10 times if everyone in the world were to live at the same standard of living as those in affluent countries such as Australia. They claim the growth of both production and freely disposable income would have to be restricted if pollution levels are to be reduced.

It would appear that as long as sustainable development is restricted to minimal low-cost adjustments that do not require value changes, institutional changes, or any sort of radical cultural adjustment, the environment will continue to be degraded. The ESD Working Group chairs, in their *Intersectoral Issues Report*, pointed out that unless substantial change occurs, the present generation may not be able to pass on an equivalent stock of environmental goods to the next generation.

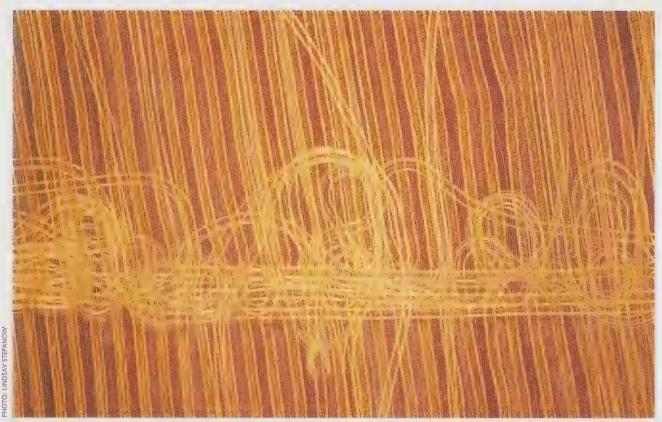
The goal of sustainable development is viewed by some economists and business groups as being merely to preserve the environment to the extent that is necessary for the maintenance of the economic system. For them, future generations can be compensated for the loss of environmental resources by increased wealth and human capital with which to meet their needs.

Such a scenario would see Australians living in an increasingly artificial world, with areas of unspoilt wilderness increasingly distant, crowded and less diverse. They would be spending more of their money and time obtaining those things that are often taken for granted today – clean air, clean water, clean food, and places to walk, play and swim. Not everyone would be able to afford these things, and certainly not every nation would be able to enjoy the living standards of Australians.

But, of course, this scenario presupposes that our policy-makers will be able to make the finely balanced decisions that ensure the preservation of those functions of ecosystems that are necessary for human survival and economic activities – that our societies are knowledgeable enough to know just how much carbon dioxide the atmosphere can take, how much pollution the air and water around us can take without triggering a sudden and irreversible collapse. Any scientist will tell you that we don't know these things.

Even if Australians put their faith in the ability of human ingenuity, in the form of technology, to be able to preserve their lifestyles and ensure an ever increasing level of consumption for everyone, technological optimism does not obviate the need for fundamental social change and a shift in priorities.

Environmentally sound technologies are unlikely to emerge from a sustainable development approach that seeks to incorporate the environment as part of the economic system and therefore to subordinate it to economic needs. There is a real need to value the environment apart from and above its input to our economic well-being, to see that environmental quality is irreplaceable. Only then will the short-term financial costs of the move towards sustainability be willingly borne by all parties.



"It would appear that as long as sustainable development is restricted to minimal low-cost adjustments that do not require value changes, institutional changes, or any sort of radical cultural adjustment, the environment will continue to be degraded."

References:

Beder, Sharon, *The Nature of Sustainable Development*, Scribe, Victoria, 1993.

Beder, Sharon, 'Pipelines and paradigms: The development of sewerage engineering', *Australian Civil Engineering Transactions*, vol CE35, no 1, March 1993, pp 79-85.

Caldart, Charles, and Ryan, William, 'Waste generation reduction', Hazardous Waste and Hazardous Materials, vol 2, no 3, 1985, pp 309–31.

Commoner, Barry, *Making Peace With the Planet*, Pantheon Books, New York, 1990.

Cramer, J, and Zegveld, W C L, 'The future role of technology in environmental management', *Futures*, vol 23, no 5, June 1991, pp 451–68.

Dadd, Debra Lynn, and Carothers, Andre, 'A bill of goods?', *Greenpeace*, vol 15, no 3, May/June 1990, pp 8–12.

Dickson, David, Alternative Technology and the Politics of Technical Change, Fontana/Collins, Great Britain, 1974.

Ecologically Sustainable Development Working Group Chairs,

Intersectoral Report, AGPS, Canberra, 1992.

Ecologically Sustainable Development Working Groups, *Final Report—Manufacturing*, AGPS, Canberra, 1991.

Hynes, H Patricia, 'The race to save the planet: Will women lose?', Women's Studies International Forum, vol 14, no 5, 1991, pp 473–8.

McCully, Patrick, 'The case against climate aid', *Ecologist*, vol 21, no 6, November/December 1991, pp 244–251.

Organisation for Economic Co-operation & Development, Economic Instruments for Environmental Protection, OECD, Paris, 1989.

Pearce, David, Markandya, Anil, and Barbier, Edward, Blueprint for a Green Economy, Earthscan, London, 1989.

Royston, M G, 'Making pollution prevention pay' in *Making Pollution Prevention Pay: Ecology with Economy as Policy*, edited by Donald Huising and Vicky Bailey, Pergamon Press, New York, 1982.

Schot, Johan, 'Constructive technology assessment and technology dynamics: The case of clean technologies', *Science, Technology, & Human Values*, vol 17, no 1, winter 1992, pp 48–50.

Charles Birch

No room in the Ark

There is a growing consensus among scientists and economists that the planet is in peril. But the solutions to our problems depend less on technological advances and economic growth than on human will guided by a 'moral compass', requiring a change of heart about how we live and work, how we produce things, and how we treat other people and other species.

COLOGISTS HAVE BEEN SAYING for years that the rich must live more simply so the poor may simply live, but this has been anathema for traditional economists.

The 12 World Bank economists who issued their dire warning in 1991 (see box 'The call for change') had two main reasons for their fears. Ecologists have calculated that, of all the plant material produced on land each year (known as the net primary production or NPP), humans directly or indirectly sequester about 40%. This figure has frightened ecologists for some time; now it's scaring some of the economists too.

The critical question they asked was, how big can the human economy be relative to the total ecosystem? Two more doublings of the economy and we will be using over 100% of the world's ecological production. So, the World Bank economists argued, an increase of five to 10 times in the world economy, as recommended by the Bruntlandt report (see box), is ecologically impossible.

Their second reason was that the world is already showing signs of reaching the limits to growth in pollution, as evidenced by the enhanced greenhouse effect and depletion of the ozone layer. Many ecologists agree that the availability of fossil fuels such as oil, coal and gas is not a critical issue – use of these fuels will have to be curbed long before they run out, due to their contribution to global warming. The beginning of the end of fossil fuels appears to be in sight.

Lester Brown, director of the Worldwatch Institute in Washington, recently published a report showing how deterioration of the world environment was adversely affecting world economic production.

Brown produced graphs of a 1990s downturn in the production of grain and meat, fish catches, fertiliser use, and the consumption of fossil fuels. All this was happening as the world's population increased by about 100 million people each year.

There is more than one explanation for these declines, but Lester Brown argues a major cause is the constraint applied by the Earth's natural systems through limits on the ability of soil to produce more grain and meat, the availability of water, and the ability of the atmosphere to absorb pollutants and of forests to withstand acid rain.

Add to this the fact that every nation in the world aims to lift its economic growth and it becomes obvious we are on a collision course. The Ark is full, and is foundering.

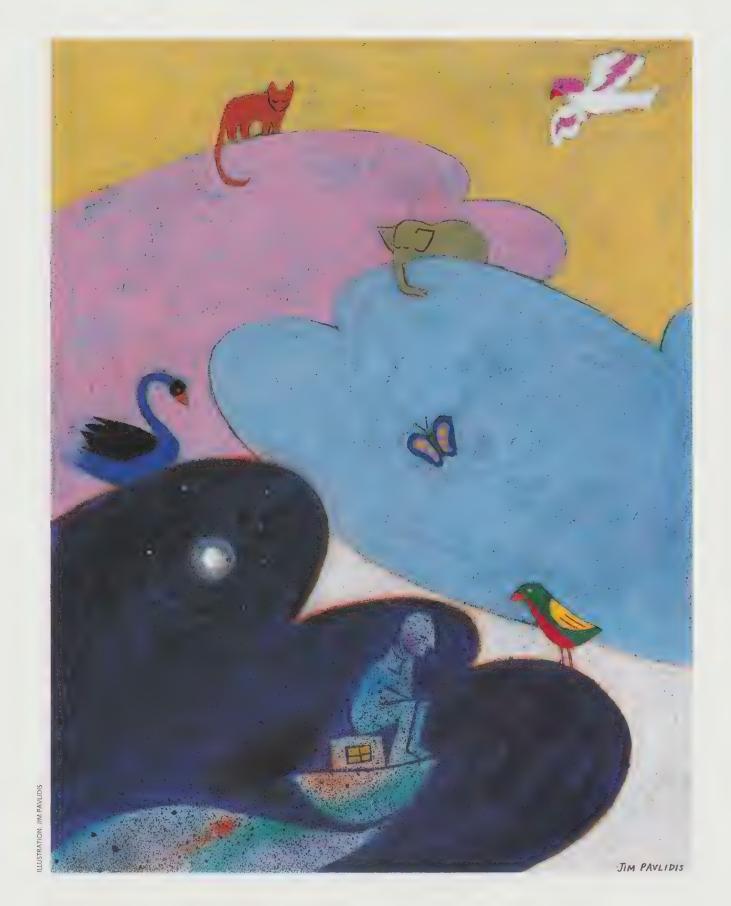
There are three main causes of environmental deterioration: the number of people, their use of resources and the deleterious effects of modern technology, such as air and water pollution. There are too many of us, using too many resources and producing too much waste. Arable land is being covered with concrete at the rate of three football fields a minute, forests are disappearing at the rate of four football fields a minute and species are disappearing at the rate of 100 a day.

If we are to achieve an ecologically sustainable society, all three components of environmental deterioration will have to be reduced.

The questions humanity now faces are profound: can we avoid the biological impoverishment of the Earth projected for the next two decades; can we protect this and future generations from harmful doses of ultraviolet radiation; can we head off runaway climate change; can we bring population and food supplies into balance so famine does not persistently stalk the Earth?

Human activities have pushed the Earth's natural life support systems dangerously out of kilter. Continuing on a 'business as usual' course virtually assures severe economic disruption, social instability and human suffering. Difficult questions are emerging in social equity, national sovereignty and individual responsibilities and rights.

No nation can afford to ignore these questions. Australia's Ark is foundering because we make a disproportionately high (on a per capita basis) contribution to the global build-up of greenhouse gases, and our use of fresh water and agriculture is unsustainable. Our negative impact on native plants and animals, one of the worst in the world, is continuing at a fast rate.



21¢**SUMMER 1993/4

SUSTAINABLE DEVELOPMENT

"What value is economic growth if it comes at the cost of the health of people and their environment?"

Our use of forests and all other renewable resources, except possibly some fisheries, is unsustainable. That we are still logging rainforest is a national disgrace. The cutting down of a rainforest for economic gain is like burning a Renaissance painting to cook the dinner.

In preparation for the 1992 UNCED Conference in Rio, the Australian government was presented – at its own request – with voluminous reports on the Australian environment. Virtually nothing has been done with these recommendations. They seem to have been put in the politically too-hard basket.

For example, because of the need to curb the use of fossil fuels, Australia – together with some other rich countries such as Germany – agreed to a 20% reduction by the year 2005. The only way of achieving this is to reduce the amount of coal and oil we use, by a carbon tax or other means. We should tax what we want less of. As yet, however, the Australian government has not backed up its promise with any action.

The USA is showing more resolve. Wind electricity generated in California already produces enough electricity to satisfy the needs of a city of the combined size of San Francisco and Washington DC.

It is obvious to me, and I hope to an increasing number of people, that only a change of heart can alter the direction in which we are heading. The World Bank economists said "only a change in heart will suffice". So did the last report from the Club of Rome, called the First Global Revolution. Maurice Strong, the Secretary General of UNCED, said at the end of the Rio conference: "I say with the strongest possible passion that we must change. I don't think the message has got through to anybody".

Many scientists believe science can solve our problems, provided we choose a path other than the one we are on. Science could show us how to proceed. If we choose to stop using fossil fuels, science will help find a way of deriving energy from the sun and the wind. If we decide to stop cutting down trees, then science will help us to find writing materials that don't require us to rid the Earth of its forests.

If all the lawyers in the USA switched to paper that was 50% recycled, the nation would save more than five million trees, 1.2 billion kilowatt hours of energy, more than nine billion litres of water, and one million cubic metres of landfill space each year. The American Bar Association estimates that each of the country's 600,000 attorneys uses an average of one ton of paper a year. We know how to recycle paper but how do we get all these lawyers to use recycled paper? Science can help us in all sorts of ways to move to an ecologically sustainable society. But we have to be persuaded we want to move in that direction.

CHANGE OF HEART FOR Australians means a change in lifestyle, in production and consumption, in our economics and our politics. Economic rationalism, for example, must go out the window to let ecological realism in. Our measure of progress will no longer be the measure of economic growth. It will be the health of the people and the health of the environment. What value is economic growth if it comes at the cost of the health of people and their environment?

A 'moral compass' for environment and development could be based on six principles. The first would be the principle of distributive global justice, by which I mean a country is deemed 'overdeveloped' when its standard of living is beyond the capacity of the world to generate for all its peoples.

We live in a world in which we are responsible for each others well-being, but our natural resources are unevenly distributed. In this decade alone, there have been some 15 international disputes relating to the sharing of water resources. The nations of sub-Saharan Africa, with 450 million people (excluding South Africa), have a total GDP less than that of Belgium, with 11 million people. The UN Children's fund says that for one billion people, which is about one-fifth of humanity, the march of human progress has now become a retreat. These facts pose an ethical problem of distributive justice.

This is a revolutionary principle which in practice means 'de-development' in rich countries and development in poor countries.

However, it is naive to suppose the world as it is now structured would ever share resources that way. President Bush told the Rio conference that the US standard of living was not up for debate.

The second principle is the principle of intergenerational equity. Does any generation have the right to exterminate plant and animal species that have existed over millions of years? The principle of intergenerational equity is that we have an obligation to preserve our biological heritage and other resources for future generations. The Brundtland report defined the sustainable society as one that "meets the needs of the present without compromising the ability of future generations to meet their needs".

Third is the principle of individual responsibility in relation to deterioration of the environment. I may be able to afford a big energy-guzzling car, but can the Earth afford it? A couple may be able to support several children, but can the Earth support several children per family?

Putting the world on a firm ecological and economic footing will severely test the capacity of individuals and national leaders, but in the end it is individuals who are being tested. The ultimate rationale for massive social mobilisation to safeguard the Earth was summed up in a graffiti on a bridge in Washington DC: "Good planets are hard to find".

Fourth is the principle of the grass roots, which observes that such changes for good as have happened already have come from the bottom up, not from the top down. The grass roots green movement led to the creation of departments of environment the world over, except for Japan. In Australia, there are 1000 local groups concerned with conservation. They are our most important nongovernment organisations. In a pluralistic democracy, legislation rarely leads public opinion — it follows or at best anticipates it by a very short lead.

The fifth is the principle of the leaven. The whole world does not have to be converted; just enough to move governments to change. Einstein said that if 2% of the people were to take a personal resolute stand against war, war would cease. Whether Einstein's estimate is as accurate as his cosmic mathematics matters not – a minority can effect great change. The creative advance of any generation rests upon the responsiveness of a piti-

fully small margin of human consciousness. Yet this small margin can bring about great change, as history has shown in the case of slavery, the campaign against nuclear weapons and the campaign to preserve the Franklin river. This is the principle of the leaven.

The sixth principle is the principle of intrinsic value, which says man is not the measure of all things. The main message of the conservation movement is that we should look after nature because nature looks after us. But there is a second sort of value we need to recognise, and that is the intrinsic value of every creature. This is the value of the individual kangaroo and lorikeet in itself, for itself, quite independent of any usefulness they may have to us.

By this principle, sentience or the capacity for feeling is

The call for change

- In 1987, the Brundtland Report of the World Commission on Environment and Development argued that the poor in the world could only be helped if there were an increase in the world economy of between five and 10 times.
- In 1991, a group of 12 economists, including two Nobel Prize winners, said in a paper published by the World Bank that the world's economy cannot grow any more. If the poor were to be fed and housed, and if the global environment was to be saved, the rich must reduce their economic growth.
- In 1992, the premier scientific societies in the UK and USA, the Royal Society of London and the US National Academy of Science, issued a joint report warning that if the predictions of population growth prove accurate and patterns of human activity on the planet remain unchanged, science and technology may not be able to prevent either irreversible degradation of the environment or continued poverty for much of the world.
- or continued poverty for much of the world.

 Later the same year, the Union of Concerned Scientists issued a statement signed by 1600 of the world's leading scientists, including 96 Nobel Prize recipients, stating that the continuation of destructive human activities "may so alter the living world that it will be unable to sustain life in the manner that we now know". The scientists said a great change in our relationship with the Earth and life was needed if vast human misery was to be avoided and the Earth preserved from irretrievable mutilation.

what gives intrinsic value. Anything with feelings commands my respect. I do not respect my motor car, although I do respect the people who made it. I respect my pet cat and the birds I feed on my balcony. Conservation at its heart is the concept that the human race must reduce its demands on the environment in favor of other species.

However, intrinsic value can be graded. Not all individuals of the creation are of equal value – the measure of intrinsic value is the capacity for richness of feelings, which has two components, harmony and zest.

The gradation of intrinsic value implies a diversity of rights. The poor and oppressed humans among us, and then whales and chimpanzees have greater rights than those of mosquitoes.

This sub-principle requires that justice, compassion and rights be extended to all creatures, the implications of which are enormous. How can we vigorously attempt to implement it in relation to issues such as methods of raising and transporting farm animals, hunting for food and fur, and the use of animals in laboratories and for entertainment? Those who destroy species in the name of development must take fearfully the command given to Noah: "Keep them alive with you".

The world and the life it supports can be saved, but only if our politics, our economics and our lifestyle are informed by a philosophy and religion relevant for our time of crisis. Like Noah, we need to make a covenant with the Earth and with every living creature, for all generations, that the world might be saved.

No room in the Ark, by Charles Birch, Biodiversity in the balance, by Harry Recher, and Managing land at the grassroots by Brian Scarsbrick are edited version of papers presented at the Horizons of Science Forum Land, Water and Life organised by the Centre for Science Communication at the University of Technology, Sydney. The Horizons of Science Forum is sponsored by the University and the Science and Technology Awareness Program of the Department of Industry, Technology and Regional Development.

The economics of global warming

More than 150 nations which signed the convention on climate change at the Earth Summit in Rio in 1992 are only now getting down to the business of generating more than warm rhetoric. Developed-country signatories (including Australia) to the Framework Convention on Climate Change are expected to ratify the treaty early next year, and begin making and implementing plans to reduce greenhouse gas emissions. Despite these moves, economists say many questions about global warming remain unanswered. What, for example, are the total costs of an emission-reduction program, and which nations and industries will be the winners and losers in a co-ordinated global effort?

the enhanced greenhouse effect must consider the total costs of action and inaction. Essentially, that means taking account of the cost of cutting (abating) greenhouse gas emissions as well as the cost of any damage associated with global warming, and measuring the costs net of associated benefits.

At the global level, the cost of greenhouse damage depends on changes in factors such as crop yields, recreational amenities and sea levels. The cost of abating greenhouse gas emissions depends on the ease with which labor, capital and clean fuels can be substituted for fossil fuels, and on many other factors, depending on which gases are being considered.

The optimal level of global greenhouse gas emissions will be that amount per year which minimises the total costs of global warming to the world's economies. Total costs are minimised when the extra cost of cutting emissions by one more tonne (the 'marginal' cost per tonne) would just balance the extra or marginal benefit from damage avoided by doing so (see Figure 1). All greenhouse gas emissions are measured in terms of tonnes of carbon dioxide equivalent warming potential.

Emission taxes and tradable permits (which permit the emission of a specified amount) are the two policy tools most often proposed to cut greenhouse gas emissions. Both instruments would generate price signals, stimulating fuel switching, technology transfer, and research and development in energy-saving technologies.

The two tools are not equivalent in practice. Because the location of the marginal abatement and damage cost curves are uncertain, there will be costs

arising from an inaccurate setting of the tax rate or the total emission limit. An emission tax is superior if, in the neighborhood of the optimal level of abatement, the marginal abatement cost curve is thought to be steeper than the marginal damage cost curve. In this case, a small error in setting the tax rate generates larger welfare losses than a small error in setting the emission limit. Conversely, a tradable permit scheme is superior if the marginal damage cost curve is thought to be steeper than the marginal abatement cost curve, since in this case it is more costly to be wrong about damage than about abatement costs.

SALLY THORPE AND BRIAN FISHER.

^{*} Edward Wheeler died on 3 October 1993. We wish to acknowledge Edward's economic research and keen editorial insights over many years.

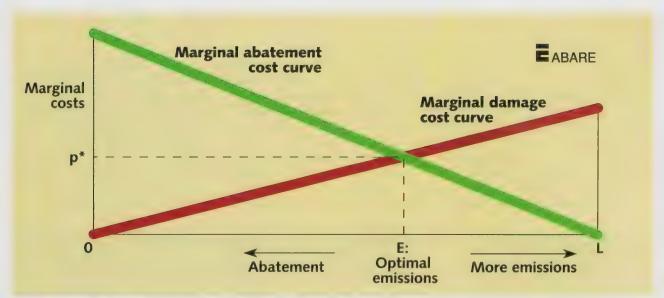


Figure 1: Marginal abatement and damage cost curves. To left of E, with more emission cuts, marginal abatement costs rise by more than the amount that marginal damage costs fall. To right of E, with more emissions, marginal damage costs rise by more than marginal abatement costs fall.

In order to formulate policies on greenhouse gas abatement, it is desirable to have estimates of the economic costs both of the possible levels of global warming and of the measures that might be taken to restrain emissions by different amounts. The ideal is to find the optimal trade-off between the two.

Typically, greenhouse gas abatement costs are estimated by using models of the world's economies to simulate the economic impacts of imposing different emission taxes or tradable permit limits on the representative demand and supply decisions of firms and consumers. Damage costs are generally estimated by taking physical predictions from scientific models of the climate system (such as predicted changes in temperatures and sea levels), translating these into changes in the value of goods and services produced per unit of labor, capital and materials, and then imposing these changes on the economic models.

Such economic models should have long time horizons for two reasons. First, the atmospheric lifetimes of most greenhouse gases exceed 50 years. Second, since the costs of emission abatement are likely to be lower the

more gradual is the adjustment, models with extended time horizons are required in order to seek the optimal time path for abatement.

UE TO ITS RELATIVE IMPORtance, most modelling of abatement has focused on cutting carbon dioxide, and a selective summary of the estimated economic impacts of carbon dioxide cuts is presented here. Other greenhouse gases such as methane are also important, but emissions for these are harder to estimate. However, to minimise the global cost of emission abatement, every greenhouse gas should be considered, to ensure that all possibilities for low-cost

reductions are exploited. Further research is required to uncover the trade-offs between gases, across the regions of the globe, and to determine possible trade-offs between emission cuts at source and reductions produced by enhancing sinks (processes which absorb the gases).

To date, the most comprehensive assessment of the costs of cutting carbon dioxide emissions has been undertaken by the OECD using a multi-region multi-sector dynamic model of the world's economies called GREEN (Burniaux et al, 1992). Half of the 'regions' are single countries but the other half are groups of countries.

Results from three simulations using

Table 1: The global cost of three GREEN scenarios: changes in real income under (i) the Framework Convention on Climate Change (FCCC); (ii) a 'Toronto'-type abatement using regional carbon taxes; and (iii) a 'Toronto'-type abatement using a tradable emission permit scheme. Estimates were derived by the OECD's GREEN model for the world's economies.

	OECD %	Non-OECD %	World %
OECD stabilisation (FCCC proposal)	-0.6	-0.3	~-0.4
Toronto target: carbon tax	-1.2	-3.2	· -2.I
Toronto target: tradable permits	-0.8	-I.I	-I.O

"Fankauser projects that by far the greatest component of damage from globa

GREEN are shown in Table 1. In the first scenario, it is assumed that all OECD regions (but not others) agree to stabilise their emissions at 1990 levels by the year 2000, as proposed in the Framework Convention on Climate Change. In the second scenario, it is assumed that both OECD and non-OECD groups of countries apply a "Toronto-type' limitation: each OECD region cuts emissions to

80% of the 1990 level by 2010 and stabilises emissions thereafter, while each non-OECD region limits emission rises to no more than 50% above their 1990 level in 2010, and stabilises them thereafter. Cuts are achieved by imposing regional carbon taxes — that is, taxing consumption of fossil fuels in proportion to each region's carbon dioxide emissions.

In a third scenario, global emission levels are the same as those in scenario two, but with a tradable emission permit scheme added. Permits for the required global total carbon dioxide output are provided, and regions buy or sell them as required, according to the respective difficulty or ease of reducing their emissions. This system is already in use for some air pollutants in the United States.

Why science worries: the scientific basis for global

HE GENERAL WARMING OF THE earth's surface and its atmosphere due to gases which absorb infra-red radiation is called 'the greenhouse effect' (see Figure 2). The chief constituents of these 'greenhouse gases' are water vapour and carbon dioxide. Other important greenhouse gases are chlorofluorocarbons (CFCs), methane, nitrous oxide and (low-altitude) ozone.

Greenhouse gases have trapped part of the Earth's radiant heat for millions of years. The natural greenhouse effect makes life on Earth possible by keeping the global average temperature about 33°C warmer than it would otherwise be. However, since the Industrial Revolution, human activities have caused a rapid build-up of greenhouse gases in the atmosphere (see Table 2). Past economic development has been strongly dependent on growth in the use of fossil fuels for energy generation, and carbon dioxide emissions from the burning of fossil fuels account for most of the global warming potential.

A conversion formula is used to derive the contribution of each of the greenhouse gases to global warming. The conversion factors take into account the atmospheric lifetimes, present concentrations and heat-trapping capacity of each of the greenhouse gases, and are expressed relative to carbon dioxide.

The major concern is that if future emission growth remains unchecked, the natural greenhouse effect could be enhanced, causing a warmer global climate, with potentially adverse effects. Reflecting this concern, the United Nations Intergovernmental Panel on Climate Change (IPCC) was set up in 1988 to provide a scientific assessment of the socio-economic implications of the global warming problem. In 1990 the IPCC reported that if nothing is done to reduce current rates of growth in greenhouse gas emissions, global temperatures could rise by around 3°C and sea levels by 65 cm by 2100 (IPCC, 1990). However, the IPCC heavily qualified these predictions to reflect major uncertainties surrounding the workings of the greenhouse effect and the climate system.

Over the past century, the recorded global temperature increased by around 0.5°C (IPCC, 1990). This figure is consistent with the existence of enhanced warming, but because the climate system is very complex and is subject to continual natural change, it cannot yet be concluded that the warming observed to date is unnatural.

Based on the main IPCC scenario for growth in greenhouse gas emissions over the next century, the IPCC noted that while there is a strong chance that the global temperature could rise by 0.3°C per decade, the temperature increase could lie anywhere within the range 0.2°C to 0.5°C per decade (IPCC, 1990). These conclusions are largely unchanged in a

Table 2: Greenhouse gas record				
	Pre-industrial concentration	Present concentration ppmv	Relative contribution to greenhouse warming potential %	
Carbon dioxide	279	354	61	
CFC-11	0	280 x 10 ⁻⁶	11 ^a	
CFC-12	0	484 x 10 ⁻⁶		
Methane	790 x 10 ⁻³	1717 x 10 ⁻³	15	
Nitrous oxide	288 x 10 ⁻³	310×10^{-3}	4	
a All CFCs. Sou	rce: IPCC (1990)			

The changes shown in Table 1 are relative to 'business-as-usual' outcomes where there are no policy responses to global warming concerns. In the first scenario, world carbon dioxide emissions in 2050 could be 11% below the business-as-usual outcome for that year, far less than the 80% reduction needed to stabilise the atmospheric concentration of carbon dioxide at about 450 parts

per million by 2050, compared with the present level of 350 ppm (IPCC as cited in Burniaux et al.). Over the period 1995 to 2050, the estimated reductions would cost OECD and non-OECD regions on average 0.6% and 0.3%, respectively, of their business-as-usual incomes (in real present values).

If non-OECD regions join with OECD regions to meet a Toronto target

(scenario two), the projected cut in global emissions by 2050 increases sharply to 64% of the business-as-usual outcome, illustrating the importance of securing co-operation from non-OECD regions if carbon dioxide levels are to be stabilised in the next century.

Scenario three shows that getting each region to individually meet the Toronto target is not cost effective.

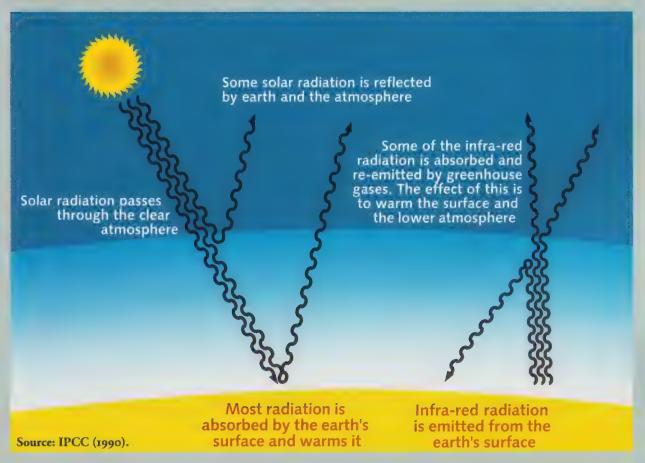
warming concerns.

supplementary assessment (IPCC, 1992).

A key source of uncertainty is the lack of knowledge regarding feedbacks within the climate system and their net impacts. As the climate warms, increased levels of water vapour would tend to further increase warming, but increased cloud cover would tend to have the

opposite effect. A major IPCC report due out in 1995 will provide an update on the science and assess options for responding to the global warming problem.

Figure 2: Simplified illustration of the Greenhouse effect



"It appears the economic impacts of global warming may be positive fo

Table 3: The wedge between energy importers and exporters: the Industry **Commission's WEDGE model** estimates of the costs arising from a 'Toronto'-type target, showing percentage changes from the business-as-usual projections in 2005 for real income and the terms of trade (an index of the prices received for exports relative to the prices paid for imports). Key components of real income include real gross domestic product and the terms of trade.

	Real income %	Terms of trade %
Australia	-1.5	-1.2
Japan	-0.6	0.6
United States	-1.2	-0.3
European		
Community	-1.3	0.7

GREEN estimates that, between 1995 and 2050, the cost of meeting the Toronto target in non-OECD regions averages around 3% of business-as-usual incomes, compared with 1% for OECD regions.

Under scenario three, the introduction of permit trading reduces the costs of achieving the same global result by around two-thirds in the non-OECD bloc and by one-third in the OECD bloc. This is due to a reallocation of emission cuts away from countries with high costs of abatement, particularly in the non-OECD regions, towards those with low costs.

How would Australia – the world's biggest exporter of coal – fare under a Toronto-type greenhouse agreement? In 1992-93, Australian coal exports earned \$7.5 billion, and total sales from the coal industry equalled 2.6% of real gross domestic product. Electricity generation

in Australia is strongly dominated by least-cost coal-fired power stations, although carbon dioxide emissions per unit of energy are far higher for coal than for other fossil fuels.

The GREEN model does not give separate results for Australia. However, the Industry Commission's multi-region multi-sector economic model, WEDGE, does separately identify Australia.

WEDGE was used by the Industry Commission (1991) to simulate the impacts of 'regional' carbon taxes sufficient to achieve a Toronto-type target. In 2005, this requires a 40% reduction in carbon dioxide emissions from business-as-usual outcomes in each 'region' of the globe (some of these regions, including Australia being single countries). Results from WEDGE for selected OECD regions are shown in Table 3.

Imposing carbon taxes on fossil fuel consumption will typically reduce the demand for these fuels, particularly coal, and depress world fossil fuel prices. In general, the terms of trade of countries which import fossil fuels are likely to improve, while those of fossil fuel exporters will deteriorate. Australia – as a major exporter – is more adversely affected than the European Community, the United States or Japan, even though the rate of carbon tax is lowest in Australia.

In 1990, Australia announced a Toronto-type Interim Planning target of reducing greenhouse gas emissions to 1988 levels by the year 2000 and to 20% below the 1988 levels by 2005. The commitment is subject to the proviso that measures have no net adverse impacts nationally or internationally (in terms of Australia's trade competitiveness), in the absence of similar action by major greenhouse gas-producing countries.

HE QUESTION RAISED BY THIS is: What would be the likely economic impact on Australia of unilateral action to meet the Interim Planning target?

Table 4: Industry Commission estimates of the impact of the Australian Government's Interim Planning target on national real gross domestic product in 2005.

	ORANI- Greenhouse %
Real GDP	-2.I
Industry outputs	
Black coal	-26.2
Brown coal	-62.3
Oil	-9.5
Gas	-19.3
Petroleum products	-11.4
Other mining	-9.4
Electricity	-7.6

According to the industry Commission's detailed multi-sector model of the Australian economy, ORANI-Greenhouse (Industry Commission, 1991), if Australia is the only country to reduce carbon dioxide emissions, and this reduction is sufficient to meet the Interim Planning target, the projected long-run cost to the Australian economy is \$8 billion in current values. In 2005, ensuring that emissions are 20% below the 1988 level and 44% below the business-as-usual outcome could reduce Australia's real gross domestic product by 2% (see Table 4).

Both WEDGE and ORANI-Greenhouse indicate that unilateral action to cut emissions is more costly to Australia than coordinated global action.

The industries most adversely affected by a national carbon tax are Australia's fossil fuel production industries. (It is assumed the revenues raised by a carbon tax are exactly offset by reductions in income and company

taxes). In 2005, outputs of brown and black coal are projected to be 62% and 26% lower, respectively, than they would otherwise have been. Energy-intensive minerals industries and electricity generation will also contract by far more than will real gross domestic product.

Simulations using a model of the Australian energy system alone (MENSA) further detail the impacts of meeting the Interim Planning target (Jones et al, 1991). For example, in MENSA projections brown coal ceases to be used as a fuel for electricity generation by 2005, and between 1990 and 2020 there is a substantial fall in the use of black coal and increased use of renewables and natural gas (see Figure 3).

Current estimates of the costs of global warming to the world's economies are highly speculative. To the extent that temperature, rainfall and sea-level changes associated with global warming are gradual, it is possible that economic systems of production and consumption may adapt to optimally

manage these changes. However, few economic models incorporate such optimal management strategies. Typically, two 'snapshots' of economies a century from now are calculated and compared — one with today's climate, the other with a global atmospheric concentration of greenhouse gases (in carbon dioxide equivalents) double that of pre-industrial times. Such comparisons contain no implicit or explicit management response to the global warming challenge.

The regional climatic impacts of global warming are poorly understood. The main global climate models have poor regional resolution and limited capacity to project seasonality, and are a weak basis for predicting the evolution of local ecosystems in response to global warming. Nevertheless, broad geographical predictions exist, and scientific research has intensified in an attempt to unravel the complexities of our climate system.

Studies of global warming damage fail to provide comprehensive estimates

of the values of the range of environmental services that may be degraded by global warming. Estimates are available for the values people place on access to recreational amenities, maintenance of human health and preservation of endangered species. In principle, these valuations can be refined and used to evaluate impacts of global warming on species loss, human health and recreational amenities. However, to do this, accurate estimates are needed of the impacts of global warming on environmental services such as clean air and water, and the uses of the world's fauna, flora and fisheries.

Many damage-cost studies also fail to incorporate the interdependencies between economic activities within and between countries. For example, while some crops may suffer under global warming, other substitute crops may benefit. The overall effect on global income could be either favorable, unchanged or unfavorable.

If a country's agricultural sector is less adversely affected than those of the

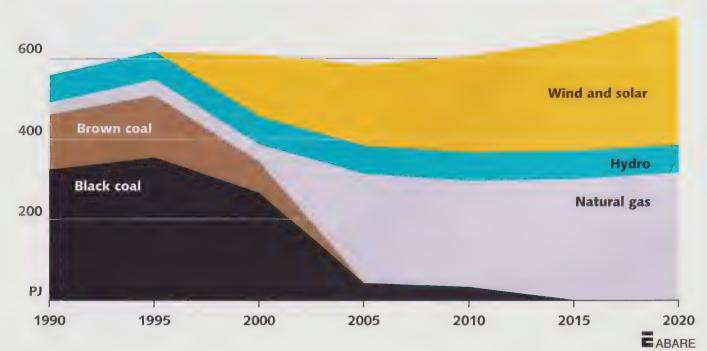


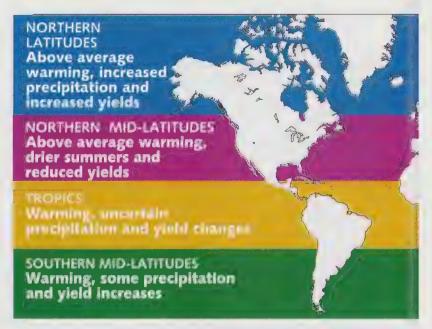
Figure 3: Australia's electricity output under Interim Planning target, according to MENSA model.

Table 5: An estimate by Fankhauser of the economic impact of a doubling in effective greenhouse gas concentrations (compared to preindustrial levels) in today's economies.

	OECD N	Non-OECI) World
	%	%	%
Total damage			
(loss in real GN	IP) 1.4	1.8	1.5
Damage share			
Coastal zone	0.3	0.9	. 0.5
Drylands	4.4	5.7	4.9
Wetlands	8.7	15.2	11.1
Species loss	9.5	10.5	9.9
Agriculture	12.7	15.5	13.7
Forestry	-5.5	-0.8	-3.8
Water	19.1	11.5	16.4
Amenity	II.O	2.9	8.1
Human health	31.5	30.9	31.3
Other	8.2	7.6	8.0
Total	100.0	100.0	100.0

rest of the world, the demand for agriculture in that country could rise. If the country is a large net agricultural exporter, its real incomes may rise if world agricultural prices rise, and the converse applies for a large net agricultural importer. An industry which is intensive in an input which becomes more costly will contract relative to industries which produce a similar product but do not require the more costly input. (Natural and synthetic textiles might be an example.) If incomes were to fall around the world, production of those goods and services which are necessities of life would be relatively less depressed than luxury production. International trade patterns would be expected to change, albeit gradually, in line with the changes in the conditions for the production of specific goods and services.

Not all studies of global warming damage suffer from all of the above



shortcomings. Indeed, the results from two studies may be used to illustrate some of the potential economic impacts of global warming. The first, by UK economist Samuel Fankhauser (cited in

Fankhauser and Pearce, 1993), incorporates projected impacts of global warming on environmental services. The second, by Kane et al (1992), illustrates how international agricultural production patterns may change with global warming, and evaluates the gains and losses to the producers and consumers of the world's agricultural products.

Results from Fankhauser's study are shown in Table 5. For a doubling of effective greenhouse gas concentrations in today's economies, he predicts that the world's real gross national product could be 1.5% lower than otherwise and that the non-OECD bloc of countries could be more adversely affected than the OECD bloc. Comparing Table 5 with the GREEN estimates (Table 1), one cannot conclude that action to prevent global warming is unjustified. Compared with the OECD bloc, it is possible the non-OECD bloc could be

worse off not only from policy responses to abate carbon dioxide emissions, but also from damages caused by policy inaction.

Fankauser projects that by far the greatest component of damage from global warming will be that to human health, in both OECD and non-OECD blocs. This is a striking result. Does it simply reflect increased heat stress and the spread of disease? What about the ability of the human species to build artificial environments? For the world as a whole, the next largest damage cost projected is to water resources, followed by agricultural, wetland and species losses. Fankhauser predicts that forest industries, particularly in the OECD bloc, will benefit significantly from a carbon-enriched atmosphere.

While regional climatic impacts are highly uncertain, climate-change models generally predict that the surface air will warm more near the poles than near the equator and more over the land than over the seas.

Godden and Schofield (1993) distinguish four direct effects on agriculture of global warming: the carbon dioxide fertilisation effect; increased temperature; changes in rainfall patterns; and

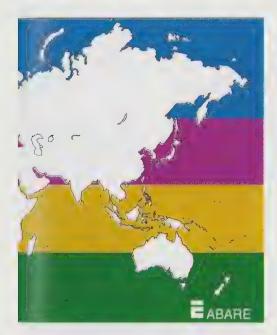


Figure 4: An estimate by Kane et al of climatic effects of global warming across broad geographic zones

growth in pests and diseases. A carbonenriched atmosphere may increase yields for many crops. As temperatures rise, holding other factors constant, plants reach maturity more quickly and food uptake and breakdown is accelerated. With enhanced warming, livestock may suffer heat stress in some regions but reduced cold stress in other regions. Changes in rainfall patterns, aside from extreme climate events, could lead to changes in management practices and favor some crops and livestock over others. Growth in pests and diseases could also lead to changes in management practices, as well as to the development of resistant agricultural species and substitution in favor of hardier species.

A study by Kane et al (1992) summarises the broad geographical impacts of global warming projected from the main climate change models (see Figure 4). In the high northern latitudes, above-average warming and rainfall may increase agricultural

Table 6: An estimate by Kane et al of the impact of a doubling in greenhouse gas concentrations (compared to pre-industrial levels) on international agricultural markets.

	REAL GDP - William YIELDS					
		Wheat	Corn	Soybean	Rice	Other
	%	1. A % 1	%	% ·	%	crops %
United States	-0.31	-20		-40	-15	-20
Canada	-0.21	-20	-5	-5		-20
European						
Community	-0.40	-15	-10	-IO		-10
Other Europe	-0.10	.10	. 15			. IO
Japan	-0.29	-5			-5	
Australia	0.04	-15	-10	-IO		-10
China	-5.48	-15	-15	-15	-15	-15
Former USSR	-0.52	-15	-10	-10	-20	15
Brazil	0.22		N	O CHANGE		
Argentina	2.82		N	O CHANGE		
Pakistan	1.63	The second state of the second	N.	O CHANGE		
Thailand	1.22		N	O CHANGE		
Rest of world	-0.84	-10	-10	-10	-10	10
World	-0.47					

productivity. In the largest grainproducing areas of the world, most of which lie within the northern midlatitudes, above-average warming and drier summers may have negative livestock and crop effects. Countries in South-East Asia may experience coastal flooding. In the southern mid-latitudes, including Australia and Argentina, some studies predict that agricultural productivity could rise with a wetter climate. In tropical regions, agricultural impacts are highly uncertain because of lack of knowledge about possible changes in rainfall and soil moisture.

HE STUDY SIMULATES THE impacts of carbon dioxide doubling on international markets for agricultural products in today's economies, distinguishing

22 agricultural goods and 13 world agricultural regions. Within agricultural markets, the model allowed for substitutions between agricultural products; however, linkages between agriculture and other markets for goods and services are ignored.

For each region and agricultural commodity, damage impacts of global warming are modelled as reductions in yields that reduce regional supplies and increase prices (and the contrary for any beneficial effects). For a high-damage impact scenario, Table 6 summarises the assumed impacts of global warming on yields, and the projected impacts of this warming on regional economic welfare. In most regions, yield effects on crops are assumed to be large and negative.

The net loss to present global income is small, at 0.5%, marginally above



Fankhauser's corresponding estimate of 0.2%. Contractions in the world's supplies of agricultural products raise agricultural prices. Around the world, producers of agricultural products gain, despite any reduction in yield, while consumers of agricultural products lose. In general, countries benefit where yields are unaffected by global warming, while other countries lose. Australia, despite reductions in yields, is a small net winner, since Australia's agricultural sector has a strong export focus, so producer gains outweigh consumer losses. Aside from China, which experiences a large loss in real income from present levels, losses in incomes are 0.4% or less.

Detailed analysis of optimal management responses by firms, households and governments to global warming risks, and of co-ordinated responses to these concerns, are the focus of a stream of proposed research by the Australian Bureau of Agricultural and Resource Economics. The research would entail the development of a multi-region multi-sector dynamic economic model, MEGABARE, to estimate the ease with which consumers and firms can substitute goods and services in reducing greenhouse emissions; help consumers and firms anticipate changes in government policy; and quantify the incentives for co-operation between countries seeking to reduce greenhouse emissions.

From the studies discussed here, it appears the economic impacts of global warming may be positive for Australian agriculture but are likely to be adverse for the world as a whole. Just how costly to the world's economy global warming might be is as yet hard to assess, partly because it is uncertain just how much warming there will be. More scientific research is needed to resolve uncertainties, particularly at the regional level. Economic research needs to be intensified to take account of factors such as producer and consumer responses intended to narrow the range of future economic impacts arising from potential global warming, and policy responses to curb greenhouse gas emissions. Optimal management strategies in an evolving economic and climatic environment need to be emphasised.

Currently, the likely benefits to the world from avoided damage by cutting carbon dioxide emissions are much less certain than the costs of doing so. Comparing available projections of the costs of cutting carbon dioxide emissions with the alternative, some modest global attempt to reduce carbon dioxide emissions may be justified before 2000. Australia, however, is a carbon-intensive economy with a large coal export sector, and so could be significantly disadvantaged by global emission abatement strategies.

References

Burniaux, J M, Martin, J P, Nicolleti, G, and Oliveira-Martins, J, 'The costs of reducing carbon dioxide emissions: evidence from GREEN', OECD Economics Department Working Papers, no 115, OECD, Paris, 1992.

Fankhauser, S, and Pearce, D W, 'The social costs of greenhouse gas emissions'. Paper presented at the OECD/ IEA conference on The Economics of Climate Change, Paris, 14-16 June 1993.

Godden, D P, and Schofield, P, 'The greenhouse effect: agriculture - our comparative advantage', Climate Change Newsletter, vol. 5, no. 3, 1993, pp 7-8.

Industry Commission, Costs and Benefits of Reducing Greenhouse Gas Emissions, 2 vols., report no. 15, AGPS, Canberra, 1991.

IPCC (Intergovernmental Panel on Climate Change), Climate Change. The IPCC Scientific Assessment, Cambridge University Press, Cambridge, 1990. Climate Change 1992. The Supplementary Report to the IPCC Scientific Assessment, Cambridge University Press, Cambridge, 1992.

Jones, B, Naughten, B, Peng, Z-Y, and Watts, S, 'Costs of reducing carbon dioxide emissions from the Australian energy sector' in **Ecologically Sustainable** Development Working Groups, Economic Modelling, Canberra (mimcograph), 1991.

Kane, S, Reilly, J, and Tobey, J, 'An empirical study of the economic effects of climate change on world agriculture', Climatic Change, vol 21,

pp 17-35, 1992.

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Weighing coal

oal is a largely invisible but essential part of the Australian way of life, providing 80 per cent of our electricity, 40 per cent of our total energy needs and nearly \$8 billion in annual export income.

Australia's iron, steel and manufacturing industries rely on coal, and so do we - every time we use electricity at home, at work or in our leisure hours.

Coal is also a fossil fuel, a resource that cannot be replaced once it has been used, although on present usage, and depending on accessibility, we could have at least 300 years worth of useable coal

reserves. The process of mining itself can change the face of the landscape. And when coal is burned to make electricity, it produces the "greenhouse gas" carbon dioxide and small amounts of atmospheric pollutants such as sulphur dioxide.

In an era of increasing awareness of the impact of human activity on the environment, one of the key challenges facing Australia, and indeed many other countries, is to apply the principles of sustainable development to an industry which is crucial for our standard of living, but which is based on a non-renewable resource and for which there is presently no alternative that is both

The coal industry is facing up to that challenge by making the most of opportunities to improve efficiency and minimise environmental impact at every stage of the process - exploration, mining, land rehabilitation, distribution, use and waste disposal.

environmentally friendly and economically viable.

Returning mined land to other productive uses is an integral part of open cut mining, while underground mining enables the landscape to be maintained in its natural state or used for other purposes such as dairy farming at the same time as the coal is being recovered. Methane gas from coal seams can be harnessed to provide additional energy.

in the environmental balance

Australia is the world's largest coal exporter but only the sixth largest coal producer, accounting for five per cent of total world production. In just the last five years, the efficiency of electricity generation has been improved by over five per cent, significantly reducing the amount of carbon dioxide

produced per unit of energy, and further improvements are on the way. The burning of coal in Australia contributes only 0.3 per cent of the world's greenhouse gases from human activity.

Because Australian coals are low in sulphur, the emission of potential pollutants such as sulphur dioxide is not a problem, and Australia does not suffer from acid rain. Our

researchers are up with the world's best in developing technologies to make coal combustion even cleaner and more efficient.

Many countries see coal as a fundamental component of their energy mix because the abundance of world coal reserves ensures competitive pricing and security of supply. Growth in Asia particularly will provide excellent opportunities for increasing exports of Australian coal and of Australian expertise in minimising the environmental impact of coal.

The wise use of Australia's non-renewable resources generates additional income and enhances our future productive capacity, ensuring that what we hand on to the next generation will be at least as valuable as what we inherited from the previous generation. What coal provides is the opportunity to maintain our current way of life while we tackle the difficult and long-term task of developing other energy sources which are truly sustainable in terms of both economy and environment.

Banking on the environment

Bankers got burnt by the financial optimism of the 1980s and are now wary of businesses which cannot prove their cash-flows are sustainable. In particular, the banks are demanding 'maximum flexibility' in the debt levels of customers affected by changing environmental concerns and policies. Financiers expect producers to thoroughly understand their processes, listen to community opinion, and adopt a pro-active approach to environmental management.

OMMERCIAL ACTIVITY INVARIably reflects the patterns of the society in which it is conducted. The material items produced and services provided will be in response to the social demands of the time and the way they are traded and delivered will follow procedures deemed appropriate by society. These procedures will be governed by the ethics and morals with which society is comfortable. This is especially true of banking.

Banks are responsible for managing the funds of individuals and corporations and are therefore in a position of trust. Society expects them to be safe and secure. To be seen to embody these qualities, successful banks must be managed by bankers who are motivated by a desire to lend only to that which has broad community support and which may, as a result, be considered reliable. Notoriety is generally a discomforting feature for bankers.

During the 1980s some bankers relied heavily on the market value of their security, as they had done in previous decades. The hype of large transactions was an accepted part of the culture of the time and seemed to ensure that asset values would continue to rise. Bankers reflected the optimism of the time. Those who insisted that asset values should depend on their cash generating capacity were derided and trampled in the rush to increase assets and obtain large fees. It was almost shameful to decline an opportunity presented by one of the so-called entrepreneurs. Now things have changed.

It has become evident that successful bankers need to focus more on busi-

nesses' cash flows and not rely simply on the value of the underlying security which has proved so fickle and hard to realise. The capacity of an enterprise to meet its financial obligations is of increasing importance, and in broad terms it can be said that the credit worthiness of a business depends on its sustainability. A business that cannot pay its debts becomes insolvent and is then wound up. In such a situation any bank lending to that business will lose some or all of the money it has lent, bringing disgrace to the lending officer and a deterioration in the performance of the bank. A moderate number of such losses can make the bank insolvent and trigger a general collapse of the economy. It is therefore crucial that the vast majority of businesses can survive to service their debts.

A banker's assessment of this sustainability of a business requires projected cashflows which are based on assumptions about future markets and costs. Bankers therefore look beyond the immediate opportunities to evaluate the prospects of a business and take a view on its costs and markets. These change constantly as society's attitudes and demands vary and bankers now need to be aware of these changes and be comfortable with their consequences.

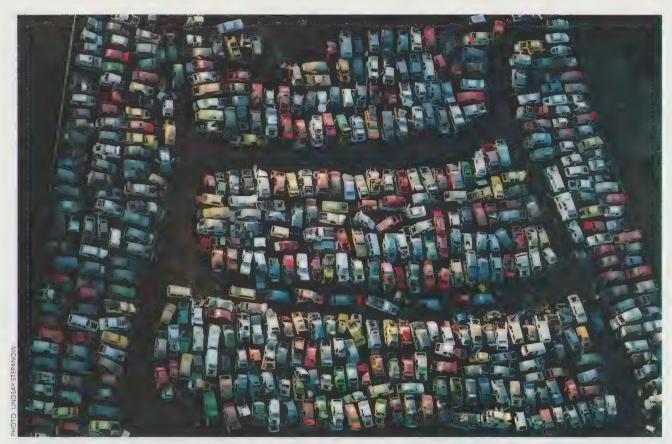
Community attitudes to the environment have changed significantly during the last few years and this is having a substantial effect on business. Businesses that do not recognise the changes and plan accordingly will suffer. The unnerving thing for company managers is that while some may have a general idea about the trends shaping

the future, they have to quantify these trends in their cashflow management and corporate planning.

Bankers derive comfort from the knowledge that their customers are ahead of the game and are strategically locating themselves to take advantage of opportunities as they arise. To do this, businesses will prepare cashflow projections and undertake market analysis for their own planning and for presentation to their financiers who will use them as a basis for an assessment. While financiers do not undertake these tasks directly themselves, they may be a catalyst for the preparation of such material. It is worth noting in passing that the advance of technology in the development of spreadsheet computer programs has facilitated this improved level of corporate management.

Financiers are witnessing a host of business changes resulting from society's developing attitude toward the environment. Basic activities may be expected to change, processes are being modified, management systems are being developed and the geographic structure of industries is under review. In some instances, however, the ultimate effect of the environmental concern may not be clear.

Greenhouse gas emissions, for example, are the subject of an international treaty, the Framework Convention on Climate Change (1992), which has been ratified by Australia. At this stage financiers, and industry for that matter, have no clear indication of the likely extent of emissions reduction and the effect that any such reductions may have on the viability of the Australian coal



"In broad terms, the creditworthiness of a business depends on its sustainability."

industry. Restrictions of emissions or carbon taxes may create a preference for the better quality coals and therefore improve the market for some Australian producers. On the other hand, the entire industry may suffer as other sources of energy are substituted for coal. The enforced substitution of coal may result in an increase of the cost of electricity and this in turn may affect the viability of industries with high electricity consumption.

In this environment of uncertainty, prudent operators in the industries likely to be affected and their financiers will limit the debt levels and tenures, thereby retaining maximum flexibility. Major developments are less likely to take place unless sponsors and financiers are convinced that the development has a competitive advantage in the energy or manufacturing sectors of the future.

Processes may change. Instead of treating wastes, businesses are sometimes adopting new processes that do not produce the same level or type of waste. The titanium dioxide industry for example has seen the introduction of plants using the chloride process and the

phasing out of the less environmentally acceptable sulphate process with its polluting wastes. This scenario is an opportunity for increased investment in industry.

The costs of waste treatment and recycling are increasingly going to be internalised, that is borne by the producer who will pass them onto the purchasers and consumers of the product. A product's price will eventually fully reflect the cost of production and disposal. To maintain a competitive edge, product design and production processes will be modified to efficiently account for the ultimate disposal or recycling of the product. The costs included in cashflow projections may not only include treatment of the waste generated during manufacture, but also the final disposal of the product itself.

The application of chemicals is going to be more carefully monitored in the future. Wool processors, for example, have to limit the levels of heavy metals in their waste emissions. Rather than install expensive equipment to treat such waste, it is preferable to restrict wool purchases to those with acceptable

levels of heavy metals. Farmers, therefore, who use or have used high levels of pesticides may find the markets for their products limited and their sustainability in question.

Financiers aim to ensure that the financial obligations of their customers do not necessitate unsustainable and unethical business practices. High-grading in mines, over-grazing of farms, over-watering of irrigation blocks, and lack of maintenance in manufacturing, all constitute unsustainable activity which in some instances have direct environmental implications. Salination of land and acid mine drainage are two results of business practice that is unsustainable.

The predictive deliniation of unethical practices in most of these instances is problematical. The answer is never black and white, although the result of an unsustainable practice may become patently obvious. Analysis in conjunction with monitored operation is the only way to proceed. Bankers rely on experts for advice about the reliability of the analysis and monitoring of a business as well as its financial trends.



"Community attitudes to the environment have also changed significantly during the last few years and this is having a substantial effect on business."

A convergence of the concerns of bankers and environmentalists is evident. Economic and environmental sustainability are intertwined. Society will never indefinitely suffer the inconvenience of a polluting industry just to retain employment. During the 1890's many Victorian towns decided for reasons of employment to allow gold dredging to continue in spite of the generation of sludge in the rivers. While the industry was not terminated perfunctorily, it was clear that if it was to continue, practices needed to be modified. Within ten years, systems and technologies were developed to enable operators to contain their sludge and rehabilitate the dredged land within the context of a viable operation. Operators who were unwilling or unable to adopt the new approaches ceased to exist.

The achievement of the sustainability

from both economic and environmental perspectives is a function of business management and its systems. The key element of any such management is a high level of pro-activity. Businesses that are reactive, and begrudgingly so, are likely to decline to extinction.

A primary feature of the management of a sustainable business is the accurate and current knowledge that it has of the production processes employed. Benchmarking is an essential feature of a competitive venture. Bankers gain a high level of comfort when customers are able to describe and quote production costs, efficiencies, rejection levels and so forth, in the context of their industry because it reveals that they are intimately aware of their businesses and are in control of them.

This high degree of control needs to be extended to environmental aspects of

a business. Plant operators now need to monitor their waste streams. The results of this monitoring should confirm that the operation is complying with its discharge licence. This is important because industry can no longer rely on the regulators and the absence of any notice or order to indicate that they are complying. Businesses now need to be able to demonstrate that they are complying with environmental regulations and the inability to do so may result in public criticism and the loss of business confidence. Increasingly bankers will be expecting this type of confirmation.

The monitoring of waste streams is also important for the evaluation of the efficiency of a operation. Gold miners who allow large amounts of gold to be lost in their tailings can only survive when mining an unusually high grade resource. Such practice is of limited application



"A convergence of the concerns of bankers and environmentalists is evident. Economic and environmental sustainability are intertwined."

and is not sustainable. Substances discarded in waste streams are often proving to have value. Reduction of waste can create significant profits because resources and energy are better utilised.

training are integral to any thorough environmental management system. In some industries employees are paid on the basis of their skill level. Their input is required for the purchasing of new equipment and the modifications to the production systems in which they participate. Employees therefore have a sense of pride in their jobs and are more likely to behave responsibly when an action has the potential to damage the environment and the reputation of their company.

Some companies are taking a proactive approach to their local communities by providing detailed information about their operations and seeking public comment. Information hotlines are being installed, open days held, and councils and community groups addressed. Managers have been surprised at the capacity of their communities to understand detailed information, and to accept that some things are not as they should be, provided that serious attempts are being made to address the situation. The result is that communities develop a certain sense of ownership of the industries in their locality. For management this means an extra area of consultation, but if it is taken seriously, community support gives added legitimacy and certainty to decisions.

Bankers derive significant comfort from knowing that a business has local support. When assessing the risks of an environmentally sensitive industry, bankers will often begin by investigating local community attitudes because it is this group that will often be the trigger for any costly environmental investigations. If these investigations have been completed and it is found that the local community is comfortable with the sensitive industry, a major area of risk has been addressed.

So we have come full circle. Community attitudes are one of the fundamentals defining sustainable industry. Government and industry action that persistently ignores the sentiments of the populous will not survive indefinitely. Bankers aim to accurately assess industry prospects in the light of community attitudes and in so doing support businesses that are sustainable. Those who do not succeed in this aim lack sustainability themselves.

Shattered shorelines harbor oceans of distress

Human attitudes to the ocean are full of contradiction.

We pump our sewage and waste into it, and yet expect to safely swim and catch fish nearby.

We flock to it for holidays, but then build resorts that destroy the beauty we came to enjoy.

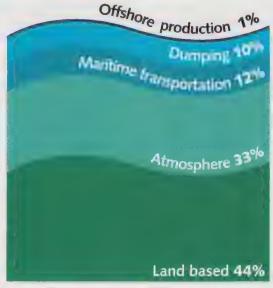
In some countries the contradictions are severe.

Fish are caught by dynamiting coral reefs, while mangroves – among the most fertile marine environments – are cleared for single-species fish farms.

While the record of ocean pollution is largely a depressing one, solutions to some of the problems are at hand.

HE WORLD'S COASTAL oceans extend from estuaries to the edge of the continental shelves, a distance usually between one and 100 km offshore. These coastal seas occupy only about half a percent of the total volume of the ocean, but within them grow around 30% of the ocean's plant and animal life. Around 50% of the world's fish catch is harvested in this coastal zone. Meanwhile, on the landward side of the coast, the first 100km is home to about 60% of the world's human population. In South-East Asia, this number rises to 75%; in Australia it is probably as high as 90%.

Human pressure on our coastal seas has been rising inexorably since the Industrial Revolution. The North Sea, cradle of that revoHow we pollute the sea: estimates of the chief sources (in percentage terms) of the pollutants entering ocean waters.



Source: UNEP, 1990.

lution, is estimated to now receive over 50,000 tonnes of heavy metals and 5 million tonnes of treated sewage each year. The nearby Mediterranean takes nearly 3 billion cubic metres of domestic waste and 30,000 tonnes of heavy metals. Yet, only in the last four or five years has the destruction of coastal seas been recognised as a major global concern. According to the United Nations Environment Program (UNEP), "the problems posed by the pollution of the marine environment from land-based sources and activities in coastal areas are among the most serious global environmental threats".

Land-based sources are those that discharge pollution direct from land to the sea. These include outfalls from sewerage



"Ninety eight per cent of the lead in the ocean (most of it from car exhausts) falls from the atmosphere."

works and factories, rivers which carry fertilisers and pesticides from agricultural land, stormwater carrying oil off roads, pesticides from termite treatments, and the slow seep of contaminated ground water.

However, while these are the sources most conspicuous to coastal dwellers, they are in no way the only means by which pollution reaches the ocean. A United Nations report, prepared by the Joint Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) has estimated the relative contributions from each of the major sources of ocean pollution (see graphic at left).

Pollution from offshore production (mining) and maritime transportation is mostly oil. 'Dumping' is, in this context, a legal term describing officially sanctioned disposal from special ships and barges, mostly of dredged material from harbors (which is often contaminated),

as well as sewage sludge and industrial waste.

The surprise in the list is perhaps the atmosphere. Much of the material released into the air through exhaust pipes and chimneys eventually settles or is rained out onto the ocean surface. 98% of the lead in the ocean, for example, (most of it from car exhausts) falls from the atmosphere, as does 40% of the heavy metals in the North Sea.

Land-based sources, however, constitute the biggest component in the list. Not only do they dominate in terms of quantity but, by comparison with other sources, they tend to be continuous, concentrated, and often close to fragile marine environments.

The GESAMP report also lists the major threats to the ocean. In decreasing order of perceived seriousness, they are: coastal development, nutrients, human pathogens, plastic, synthetic chemicals,

oil, heavy metals and radionuclides. The list provides an opportunity to examine the plight of coastlines around the world.

The threat of coastal development is obvious. The construction of buildings, harbours and other shoreline amenities, including fish farms, often leads to the destruction of natural habitats. While there is well founded concern in Australia about near-shore development, particularly of tourist complexes, our coastal destruction pales against that in some of the developing nations.

Bearing the full force of the destruction are mangrove swamps and coral reefs, two of the most diverse and productive environments on earth. One estimate, by D. Hinrichsen, in a UNEP-sponsored study, suggests that one hectare of carefully-managed mangroves could sustain annual production of over 300kg of fish and shellfish, plus another

475kg of fish that use the mangroves as a nursery area. Despite this, around 50% of mangroves in South-East Asia have now been destroyed to make way for buildings, fish farms, or simply to provide woodchips.

Coral reefs are destroyed for different reasons. In a UNEP survey reported by Hinrichsen, 41 countries report "serious problems" with dynamite fishing. Another Asian and South Pacific fishing practice is the use of poisons such as sodium cyanide. Again, these kill not only the fish, but also the reefs (and probably do not enhance the health of consumers). Coral is also cut as blocks for use as a building material that apparently resembles marble when polished. The net result of this exploitation is that in countries like the Philippines, where 55% of the fish catch is from coral reefs, only 10% of the reefs are now regarded as undamaged.

The clearing of land for coastal and hinterland development leads to erosion, with increased loads of silt washing off the land during rainfall. Silt can simply kill a coral reef by smothering it, and, in the same UNEP survey, 50 countries report "excessive siltation" of coral reefs. Sea-grasses, the flowering plants of the shallow coastal waters, play a similar role to corals as nursery areas and habitats for fish. They too are destroyed by smothering. In an Australian example, 70% of seagrasses in Westernport Bay near Melbourne are considered to have died through silt inundation.

River runoff carries not only silt, but also nitrogen and phosphorus from farmland fertilisers. These are the 'nutrients' of the GESAMP list. Besides farmlands, the other major source of nutrients is sewage. An excess of nutrients in water is known as 'eutrophication', which encourages plant growth. Australians have seen the dramatic results of eutrophication in fresh water in the algal blooms in the Darling River. Algal blooms are common in coastal estuaries and bays

and the consequences for marine and freshwater life can be disastrous. Firstly, with thick algal growth, no sunlight gets through to the plants and creatures below. Once the algae die and begin to rot, they use up huge amounts of oxygen, and produce poisonous hydrogen sulphide (H₂S) gas. One of the largest ocean blooms engulfed 200km of the Swedish, Norwegian and Danish coasts in 1988, killing marine plants and fish.

O ADD FURTHER TO THE HAVOC, an alga in bloom may produce a toxic excretion. An unidentified toxin released in the 1988 bloom cost the Norwegian salmon industry an estimated \$15 million in losses. These toxins have an insidious ability to accumulate in shellfish, apparently causing no damage to the shellfish itself. However, the consequences may

"Bearing the full force of the destruction are mangrove swamps and coral reefs, two of the most diverse and productive environments on earth."

be serious poisoning, and even death for animals and humans consuming the shellfish. Between 1969 and 1983, for example, Canada recorded 905 cases of paralytic shellfish poisoning, including 24 deaths.

Human pathogens (bacteria and viruses that transmit human diseases) similarly accumulate in shellfish near to sewage outfalls. The fish take in the contaminants with their food, but store rather than excrete them. On the Mediterranean coastline, which attracts about one-third of the world's tourists, only 30% of sewage receives any treatment before its release to the water. In these areas, the consumption of raw shellfish can cause outbreaks of hepatitis, salmonella poisoning, typhoid and cholera.

Tourists, at least, have choice in their

food. In some of the larger cities of the developing world, such as Manila and Jakarta, slum housing is built right on the water's edge. The residents have little option but to catch fish, a staple diet, in water visibly polluted with sewage. Stomach and intestinal diseases are rife, and diarrhoea is a major cause of child mortality. In Bangkok, the city's drinking water - drawn from groundwater beneath the city - is now contaminated with sewage. Simply swimming in sewage-polluted water can lead to infections of the stomach, ears, eyes, skin and throat. In the Mediterranean, around 20% of beaches are regarded as completely unsafe for swimming. While sewage is an inevitable consequence of human existence, its presence on beaches is not.

Another pollutant, plastic, is a symbol of our consumer society. Not only is plastic virtually indestructible, but it also floats. For this reason, plastic debris is now found on even the most isolated coastlines. The debris is a death trap for marine creatures, particularly mammals and sea-birds, which can choke on swallowed plastic or become entangled. Up to 10% of North Pacific fur seals are believed to be killed each year in discarded plastic fishing nets. There is basically no excuse for plastics in the ocean.

While the problem of plastics can hopefully be eliminated by education, pollution from other synthetic materials will be more difficult to solve. There are now an estimated 70,000 chemical compounds in daily use. Each year, a further 500 to 1,000 new chemicals are released onto the market, usually with no thought of how they will ultimately be disposed. The United States alone produces 400 million tonnes of industrial waste per year. Inevitably, by design or accident, some of society's chemical waste finds its way to the ocean, down drains, rivers, sewerage pipes, and via chimney stacks.

Two case studies give cause for thought. PCBs, which were used in a

range of applications like glues, paints and transformers, and the pesticide DDT, were both introduced in the 1930s. Although banned from production, at least in the Western world, since the 1970s, they are persistent chemicals that have been spread by winds and ocean currents, and are now found at the poles and in the deep ocean.

Although at very low concentrations

in the water and on the sea bed, the chemicals accumulate in the flesh of marine creatures, increasing in concentration towards the top of the ocean food chain. Marine mammals contaminated with PCBs are known to have impaired immunity and reproduction. Marine birds consuming DDTcontaminated fish produce eggs with shells so weak the offspring rarely survive. Even at low levels, chemical contaminants in the ocean have the potential to cause subtle and long-term effects that may ultimately threaten the existence of a species.

The last three items on the GESAMP list, oil,

metals and radionuclides, are all chemicals that raise similar concerns to those we have just discussed. Oil, of course, can cause spectacular local destruction after an accidental release. However, the major ocean pollution from oil results from routine operations such as bilgecleaning and leakage during transfers. In the Caribbean and the Mediterranean, for example, washed-up tar-balls desecrate tourist beaches. Persistent leakage from oil installations can place marine environment under stress - this has happened to mangroves in Botany Bay.

Metals are well known as contaminants. Most are virtually insoluble in sea-water, and tend to sink to the bottom, creating 'hot spots' that may cause problems for shellfish culture or harbor dredging. Mercury is a particular concern, because it has a soluble form. In the notorious Minimata case in Japan, over 2,000 people suffered poisoning and 43 ultimately died from eating fish contaminated with the mercury waste from a plastics factory.

Radionuclides, or radioactive chemicals, occur naturally in the ocean, but



are also introduced by bomb tests, accidents and leakage. Ocean disposal of radioactive material is presently banned, and the only problems were considered to be a few hot-spots near nuclear installations until Russia admitted dumping nuclear waste in the sea of Japan.

The tale of the ocean pollution is essentially a depressing one. The magnitude of coastal destruction has largely been ignored until recently because the stories and issues, although repeated from country to country, were regarded as local problems. The 'big picture' seems not to have been pieced together. However, as countries bordering the Mediterranean and North Seas know, pollution does not stop at national

boundaries. The problems are often common and will only be solved by cooperation. As UNEP has stated, "a meaningful approach to the control of pollution from land based sources and activities in coastal areas requires a comprehensive, sequential and co-ordinated approach involving political, social, economic, management, scientific, technical, legal and institutional

factors, measures and mechanisms". Sounds simple doesn't it?

There is, however, some cause for optimism. UNEP has clearly recognised the problem, and is struggling toward solutions. It has estimated it will cost between \$US25 and \$100 billion to clean up the Mediterranean alone, which initially sounds impossibly expensive but is really only \$5-\$20 dollars per resident and tourist each year for 20 years.

In Australia, we are probably lucky. We have a long open coastline, a small population, and are not highly industrialised. Every coastal resident will, however, be able to identify

with at least one of the coastal problems I have discussed. Our relatively clean coast-line is not a result of a superior foresight or talent. We should beware the lessons from other countries, and be prepared to discuss our neighbors in their quest for a clean, healthy coastal environment.

References

The state of the marine environment.

Joint Group of Experts on the
Scientific Aspects of Marine
Pollution. UNEP Regional Seas Reports
& Studies No. 115 (GESAMP No. 39),
UNEP, 1990.

Our common seas: coasts in crisis. Don Hinrichsen. Earthscan in association with UNEP, 1990.

Environmental book-keeping reveals conflicting accounts

What price the last rhino horn or kilo of whale meat? Economic rationality would lead us to exploit the environment to extinction, because it puts no value on 'priceless' natural resources and fails to recognise that incentives to exploit nature can exceed nature's capacity to renew itself. Addressing these conflicts in favor of sustainable development will require pricing environmental resources such as fertile soil and clean air, setting limits on resource use, and finding new economic methods for evaluating development projects.

the conflicts that occur between economic rationality and sustainable development. The first conflict occurs because environmental resources are considered to have no economic value or price, and are excluded from economic analysis.

In economic terms, they are 'externalities'. This occurs in business production and consumer purchase decisions, and at a macroeconomic level in national income accounts. Examples of the latter include the value of soil to agricultural production, the value of trees to forestry, and the value of the assimilative capacity of the environment to absorb wastes from industry.

The second occurs when, for various reasons, economic incentives exceed environmental capacities. An instance of this is when a conflict arises due to economic evaluations that favor short-term resource use. A second instance is when economic discount rates are higher

than natural reproduction rates. Clark (1976) has shown that, because the economic rate of return from whaling exceeds the whale's rate of reproduction, it is economically rational to hunt whales to the point of extinction.

A third instance is when a common resource is used beyond its carrying capacity. As Harden (1968) has demonstrated, there is no incentive for a particular user of the commons to withdraw his demands for use of the common resource when the carrying capacity is exceeded.

For this conflict – that is, when incentives exceed capacity – to be resolved in favor of sustainable development, it is necessary for resource management constraints to be determined, and for economic optimization to occur within those constraints.

In relation to resource use, two key principles apply: the rate of use of renewable resources is limited by the rate of regeneration of the resource; and, the rate of use of non-renewable resources is limited by the rates of recycling and substitution by non-renewable resources.

The implementation of sustainable development also requires the re-evaluation of the value system underlying development, the methods of economic evaluation of development, and the establishment of appropriate policy frameworks for resource use.

The inefficient use of natural resources (inefficient, that is, from a social perspective), and environmental degradation, can be reduced if producers and consumers face the full costs of their decisions and not just the direct costs. Economic incentives to help achieve this include pollution and product charges, and tax differentiation.

Pollution charges act as incentives by encouraging polluters to reduce releases; and they have a financial impact since the funds collected are mostly spent on pollution control. A review of practice in OECD countries indicates that charges are seldom high enough to offer much incentive, so their financial function is usually more important. However, in the Netherlands where effluent charges form the backbone of the water management system, the levels are sufficiently high to constitute a strong incentive to clean up water pollution (Opschoor and

Vos, 1989).

Melbourne Water (MMBW, 1979) has restructured its trade waste pricing policy to reflect the cost of treatment, and this has led some industries to install higher levels of treatment and reduce wastewater discharges.

Charges can also apply to products to reflect costs of environmental management or provide incentives for proper disposal. Examples of product charges include a levy placed on chemical manufacturers in the United States. The levy has been used to create the US EPA's Superfund for cleaning up contaminated waste dumps. There is a similar levy on extractive industries production in South Australia for the rehabilitation of disused quarries.

The incentive schemes usually involve a deposit-refund system. South Australia has legislation that places a charge on containers, which can be recouped when the container is recycled. This has been effective in reducing litter but has come under legal attack as a restraint on trade. A similar approach has been recommended to stop the indiscriminate disposal of hazardous wastes (Russell, 1988).

The refund provides an incentive to follow rules for proper disposal, recapture would-be losses from the production process, or look for nonhazardous substitutes. It also helps agencies eliminate the nearly impossible task of monitoring and preventing illegal dumping of small quantities of wastes at

Robert Repetto, has argued that national income accounts, which are used to determine gross and net national product, ought to encompass the concept of sustainability (Repetto et al., 1989).

Gross national product (GNP) is the principal indicator of economic progress and transformation. It is a measure of the total value of the production of

> occurs during a year. A more relevant measure is the net national product (NNP), which allows

goods and services which

for depreciation in the equipment and resources used in the production process. However, GNP and NNP only consider man-made assets and activity. For example, the costs associated with the clean-up of an oil spill make a positive contribution to GNP while any damage to environment is

included. As Repetto put it, under the present system of national accounts, "a country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers and hunt its wildlife and fisheries to extinction, but measured income would not be affected

as these assets disappeared."

Nevertheless, the fundamental definition of income does encompass the notion of sustainability. Income is defined as the maximum amount the recipient could consume in a given period without reducing the amount of possible consumption in a future period. Business income is defined as the maximum amount the firm could pay out in current dividends without reducing net worth. Thus the concept of income encompasses not only current earnings but also changes in asset positions; capi-



dispersed sites in the environment.

Taxation has been used in a variety of ways to modify prices and resource use. Sales tax differentiation has been used to modify the relative prices of products by penalizing those harmful to the environment. In several OECD countries, tax differentiation on petrol is aimed at encouraging the use of lead-free petrol.

There has also been the removal of tax subsidies of environmentally destructive activities, such as land clearance in South Australia, which was until recently tax deductible.

The chief economist of the World Resources Institute in Washington, Dr

SUSTAINABLE DEVELOPMENT

"This difference in the treatment of natural resources promotes the idea that rapid rates of economic growth can be sustained by exploiting the natural resource base."

tal gains are a source of income while capital losses are a reduction in income. The depreciation accounts of the national accounts reflect the fact that unless the capital stock is maintained and replaced, future consumption possibilities will inevitably decline. In resource-dependent countries like

Australia, failure to extend this depreciation concept to the capital stock embodied in natural resources is a major omission and inconsistency.

This difference in the treatment of natural resources provides false signals to policy makers in that it leads them to deplete natural resources in the name of economic development, and promotes the idea that rapid rates of economic growth can be sustained by exploiting the natural resource base. The result can be illusory gains in income and permanent losses in wealth.

While all would agree in principle that a good natural resource base yields a continuing flow of beneficial goods and services, valuing those benefits is complex.

There are three principal methods for estimating the value of natural resource stocks:

- the present value of future net
- the transaction value of market purchases of the resource in situ;
- the net price (i.e. current increases less current production costs) of the resource multiplied by the relevant quantity of the reserve.

An illustration of this approach has been presented by Repetto et al. in relation to soil erosion in Indonesia. This analysis

not only illustrates the economic significance of the depletion of natural resources but also illustrates the difficulty in obtaining relevant data to

undertake the analysis.

mating erosion rates for these land uses for each of the applicable soil types in excess of natural erosion rates.

The one-year costs of erosion were capitalized to obtain a total present value of future losses of US\$484 million or about 4% of annual value of dryland farm output - of the same order of magnitude as annual recorded

> tion in the uplands. Thus, each current increment in production is offset by an equal but unrecorded loss in soil productivity.

growth in agricultural produc-

Putting a monetary value upon natural resources is not always enough to ensure sustainable development. In some instances, there are economic incentives to use natural resources beyond the environmental capacity to sustain that use. In these circumstances, there is a need to define a resource management constraint to restrict resource use to a sustainable level.

The concept of carrying capacity is central to sustainability. A region's carrying capacity can be defined as the maximum rate of resource consumption and waste discharge that can be sustained indefinitely without progressively impairing bio-productivity and ecological integrity.

The long-term goal is to balance the human population's need for a resource and the availability of that resource. With increasing population and desires for improved standard of living, there is an increasing demand for many resources. If demand exceeds carrying capacity or a sustainable yield then eventually there can be a decline in resource availability. The economic argument is

Removing part of Indonesia's topsoil and depositing it elsewhere lowers the agricultural potential and economic value of the eroded land. The loss of potential future farm income is equivalent to the depreciation of an economic asset. Besides the on-site costs of soil erosion, there are off-site or downstream costs such as siltation of reservoirs and irrigation systems, harbors and other waterways.

Establishing physical accounts for soil throughout Indonesia required classifying all soil types and slopes, mapping rainfall-erosivity energy, identifying all principal agricultural land uses, and esti"A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers and hunt its wildlife to extinction, but measured income would not be affected as these assets disappeared"

- Robert Repetto.

that population needs can be met through mechanisms such as price increases, technological improvement, replacement by substitutes and the development of more economically marginal resources. For example, high gold prices have led to reprocessing of old gold mine tailings and open cutting of old underground mines. However, for some natural resources, these economic arguments lead to adverse consequences, as borne out by the history

of whaling (Cherfas,

As early as 1908, Britain - which administered the whaling stations in the Antarctic tried to introduce a licensing system and tax on whale oil to prevent the depletion of whale stocks. To avoid these controls, the Norwegians invented the floating factory ship. A second attempt at control occurred in 1931 when the whale catch was so large the price of whale oil fell dramatically. An Association of Whaling Companies was formed to establish a quota system to limit production. However, with a limit on total catch, there was intense competition to maximize the share of the catch. This resulted in an overinvestment in equipment and a shorter whaling season. In 1961, there were private agreements on the division of the catch with a subsequent reduction in investment in equipment and a longer whaling season. These are examples of

limits on resource depletion. However, the limits were above sustainable yields, leading to a dramatic decline in catch in the 1960s as whale stocks were depleted. In 1981, the International Whaling Commission

market-related mechanisms placing

(IWC) introduced bans on the hunt of sperm whales and, in 1985, a complete halt to commercial whaling. However, some countries are still hunting whales through loopholes in the moratorium rules.

quota. The difficulty would be in ensuring compliance receiving environment for that

The reason why the hunting countries continue to harvest whales is because it makes economic sense to do so. In simple terms, there is an investment decision between 'milking' the resource (i.e. harvesting at the sustainable yield) or 'mining' the resource (i.e. extracting the entire resource and investing the funds elsewhere).

If the total value of the resource is \$P then the return from the milking strategy is \$Pa where 'a' is the net rate of reproduction, while the return from the mining strategy is \$Pi where 'i' is the interest rate from other investments. If 'i' exceeds 'a' then the rational investment decision is to mine the resource.

One suggestion has been to establish a World Whaling Authority which can sell annual quotas to the highest bidders up to the sustainable yield of the whale population (Clark, 1976). The income would provide the funds to run the authority. Conservationists could even

bid against whalers for an annual

with the quota system. A similar concept is the use of trading emission rights. A limit on the discharge of a particular emission is established for a particular environment and dischargers have to purchase emission rights if they wish to discharge to that receiving environment. For sustainable development, the limit has to be set at or below the assimilative capacity of the

These emissions rights can be traded. Thus a new firm wishing to establish, after the emission limit has been reached, has to purchase emis sion rights from existing dischargers. The dischargers which sell rights are then required to reduce emissions by the amount sold. A discharger wish ing to expand can either reduce its own emissions from existing operations or purchase emission rights from others.

In this way, emissions are controlled at the least cost. If the price is right, dischargers with low emission control costs can be induced to sell emission rights to dischargers with high emission control costs. The traded price should match the marginal cost of the least

SUSTAINABLE DEVELOPMENT

"Putting a monetary value upon natural resources is not always enough to ensure sustainable development."

expensive emission to control in the region.

The experience of Dillon Reservoir, the major source of water for the City of Denver, Colorado, provides an excellent example of a trading approach that works effectively on non-point source water pollution (Stavins, 1989). In past years, nitrogen and phosphorus loading caused the reservoir to become eutrophic, even though point sources from surrounding communities were controlled to 'best-available-technology' standards. To preserve and protect water quality in the face of rapid growth, the US EPA and the State of Colorado jointly developed a point/non-point source control optimization program to cut the phosphorus flows that mainly came from non-point urban and agricultural sources.

The program allows for publicly-owned sewerage works to finance the control of non-point sources in lieu of upgrading their own treated effluent to drinking-water standards. The program is effective because the cost per pound of phosphorus removed via trading is \$67; whereas the cheapest advanced treatment alternative developed for the sewerage works would cost \$824 a pound. EPA has estimated that the plan has saved more than \$1million a year.

The traditional value system underlying development has been one of market forces. The view set out by the Business Council of Australia (BCA) is that:

The key to preventing environmental misuse and achieving sustainable development lies in providing the correct structure of incentives for all users of the environment."

The BCA advocates market-based approaches, with the most efficient use of resources being achieved through pricing policies that take into account the social costs of using a resource.

However, as shown above, there are circumstances when economic incentives are in conflict with sustainable development. This implies the need for a change in values. Hardin (1983) advocates mutual coercion, mutually agreed, as the way to get the appropriate commitment.

CONOMIC EVALUATIONS OF development (such as benefit cost analysis and net present value analysis) that rely on discounted cash flow calculations, by definition, discount future benefits. The discounting of future benefits and costs can mitigate against sustainable development.

For example, the World Bank approved irrigation developments in India without drainage even though this would inevitable create a salty swamp. Drainage was excluded because the land was already productive so the added cost of putting in drains meant the project would fail the bank's test of a return of 10% on investment. The accepted economic justification for proceeding with the investment was certain to lead to a degrading of the resource base, and there was no acceptable justification for protecting the resource from destruction (Timberlake, 1988).

Even when drainage is provided, benefit cost analysis can influence the saline water disposal options considered viable. In the River Murray Basin, the most economical form of drainage of saline groundwater from irrigated areas and diversion of highly saline, naturally occurring groundwater, is generally by groundwater interception and disposal to an evaporation basin. As there is leakage from these basins, the saline water will eventually return to the river at the same rate that it is being diverted. However, it takes hundreds of years before this occurs. These schemes show, in a benefit cost analysis, significant economic benefits over the first 50 years. Yet, piping the saline water to the sea - which would not involve returning salt to the river or losing land to evaporation basins - is not economically viable because of the high initial capital cost. In benefit cost analysis, the future benefits are so heavily discounted they do not warrant consideration.

There are a number of ways the economic evaluation of projects can be modified to better reflect sustainable development. One is to place monetary values on environment costs and benefits and incorporate those values into the benefit cost analysis. This does not overcome the problem of discounting the future, but can place greater emphasis on environmental values in relation to purely financial considerations. An example of this is the evaluation of alternative strategies to protect Adelaide's metropolitan coastline (Kinhill Stearns and Riedel and Byrne, 1983). In purely financial terms, alternative strategies could be compared in terms of the cost of implementation and benefits of property values protected. On this basis, the construction of sea walls was the preferred strategy. However, when a value was put on beach amenity (based on the costs people were willing to incur to travel to the beach), beach replenishment strategies were economic, while sea-wall construction, which accelerated beach erosion, became uneconomic

the 'polluter pays' principle and ensure environmental costs are borne by the proponent of a project, and are therefore brought directly into the economic analysis. One example of this is the use of rehabilitation bonds for mining companies to ensure sufficient funds are available for rehabilitation of disturbed areas after mine closure.

A third approach is to treat economic analysis as only one component of project evaluation. Not all environmental consideration can be readily quantified in monetary terms, nor can future considerations pertaining to sustainability be adequately represented when heavily discounted. Techniques such as planning balance sheets display the relative merits of alternatives across a range of evaluation

criteria. This enables decision makers to make explicit trade-offs between criteria so that monetary benefit cost considerations do not always prevail.

Another view is that discounted cash flow analysis is not an appropriate measure because it reflects the rate of use of resources rather than their rational economic management. Resource use may be more appropriately viewed

as conservation of stocks rather than use of flows (Redclift, 1988).

An alternative view is to regard natural resources as capital assets. Projects involving natural resource depletion would, therefore, involve capital asset depreciation. The financial analogy is the company balance sheet. A company is not only expected to earn a profit (i.e. equivalent to return on investment. which is central to discounted cash flow analysis), but also to have current assets (i.e. resources available for use) to meet current liabilities (i.e. demands for resource use), and to have fixed assets (i.e. resource stocks) to meet current liabilities (i.e. demands for

resource use), and to have fixed assets (i.e. resource stocks) to meet long-term liabilities (i.e. resource demands of future generations).

These forms of analysis are relevant to the implementation of sustainable development.

In conclusion, for sustainable development to occur, two conflicts between economic rationality and environmental resources need to

be addressed. The first conflict could be addressed through the introduction of pollution charges, product charges and tax differentiation. It also requires natural resource assets and their depletion to be incorporated into national accounting to properly reflect a nation's wealth. The second conflict requires the establishment of an enforceable resource management constraint to limit resource extraction

References

Cherfas, J. 1986. What price whales? New Scientist 5 June 1986, pp 36-40. Clark, C. 1976. Mathematical bioeconomics. New York: Wiley. Edney, J. 1979. Free riders enroute to disaster. Psychol. Today, 80-87, 102. Great Barrier Reef Marine Park Authority, 1980. Great Barrier Reef Marine Park Capricornia Section: Understanding the Zoning Plan. Hardin, G. 1968. The tragedy of the commons. Science Vol. No.162 December. pp 1243-1284. Holling, D.S. 1978. Adaptive Environmental Assessment and Management. Wiley, Chishester.

Kinhill Stearns and Riedel and Byrne, 1983. Adelaide Coast Protection Alternatives Study. Report to the Coast Protection Board, Adelaide.

Melbourne and Metropolitan Board of Works. 1979. Trade waste charging and acceptance policy. MMBW, Melbourne. Opschoor, J.B. and H.B. Vos. 1989. The application of economic instruments for environmental protection in OECD member countries. OECD Publication,

Redclift, M. 1988. Economic models and environmental values: a discourse on theory. In: R.K. Turner (Ed.), Sustainable Environment Management: Principles and Practice. Belhaven press, London. Repetto, R. et al. 1989. Wasting assets: Natural resources in the national income accounts. World Resources Institute, Washington DC.

to a sustainable level.

Russell, C.S. 1988. Economic incentives in the management of hazardous wastes. *Columbia Journal of Environmental Law*, Vol. 13, pp 257–274.

Steeds, D. 1985. Desertification in the Sahelian and Sudanian Zones in West Africa. World Bank, Washington, DC. Timberlank, 1988. Sustained hope for development. *New Sci.*, 7 July 1988.

21C: Can you give us an idea of the importance of water research to sustainable development?

GRAHAM ALLISON: Well, Australia is a country with its water resources under stress, very much in terms of quality, from salinity and nutrients. Groundwater is under stress from those two issues, plus contamination from a range of other sources such as hydrocarbons.

Hydrocarbons? From where?

Petrol stations would be a good start. Many petrol stations leak. And we find that in Perth, where 30% to 40% of the city's water comes from groundwater, some of the water supply wells are coming under threat because of leaky petrol tanks. It doesn't require much petroleum to leak from a service station to seriously degrade water resources.

So we need to know a lot more about water?

Without understanding water, we don't understand how the environment works. It's a key issue in

anything to do with waste management because most waste management is all about water management, whether it's a nuclear waste repository or a simple urban landfill. The major concern people have is over what leaches from those waste repositories. And that's all about understanding how water moves. Remember that landscape salinisation is brought about by water movement — nothing else.

We might have greatly changed landscapes from those 200 years ago but people don't seem to be too bothered by green fields with few trees. But if they see watercourses that are filled with algae or with very little water flowing in them,

they get very concerned. Water is a good indicator of how we are treating the landscape.

Your (CSIRO) division recently conducted a survey of research opportunities raised by the sustainability of irrigation. Do you think irrigated farming is an environmental hazard? Sometimes yes and sometimes no. The reason we wanted to look at research

Water's **vital** profile

How we use water is fair indicator of how well we treat the environment, says Graham Allison, chief of the CSIRO Division of Water Resources. He spoke to Brett Wright about the tasks facing Australia in achieving sustainability in water quality and use.

opportunities in irrigated agriculture is because it uses much of our water.

Is irrigated farming sustainable?

It can be, with a couple of provisos. You must make sure you don't get salt up into the root zone, and you must make sure you don't have waterlogging.

As the adage goes, isn't rain best used where it falls?

Yes, but there are a whole range of crops you can't grow by rain-fed agriculture – such as horticultural crops. We mustn't lose sight of the fact that irrigated agriculture in Australia is worth over four billion dollars to the economy.

What then are the downsides and upsides?

The downside is that the use of such large quantities of water means the nature of our river systems has changed, creating the potential for irrigation-induced salinisation and waterlogging. The upsides are the possibility for non-urban development — which is important as Australia is already one of the most urbanised countries around —

and the establishment of rural processing industries.

Aren't our groundwater supplies being depleted by irrigation?

In some areas they are, but the major problem is the decline of groundwater quality, certainly in the shallow aquifers.

Victoria's Office of the Environment says that 90% of the state's irrigated farmland shows signs of a severe decline in soil structure, and that half of the horticultural land suffers from moderate water erosion. Is there a danger that present-day uses of agricultural water will eventually destroy our

agricultural base?

'Destroy' is too strong a word, but there's certainly a danger we will have significantly reduced incomes due to degradation. This is a definite possibility for those industries which are profligate users of water.

Which industries are they?

Some of the irrigated pastures, particularly in those areas where we are using fairly inefficient methods such as flood irrigation or furrow irrigation on permeable soils.

Do we need to make major changes to agricultural practices?

We have to make some changes – whether they're major or not, I don't know. We use an excess amount of water and that ends up in the root zone, which brings about a rise in the watertable. And as soon as you get watertables near the surface, you have the possibility of salt being concentrated.

Is salinity fixable?

Enough money will fix anything. In an

economic sense, though, it's probably not.

Probably the most important of salinity problems in Australia is dryland salinity, which is brought about through clearing. The big issue is that Australia has to decide what it wants its landscapes to look like. I don't believe we can afford to revegetate the landscape, and if you could and did, we would no longer have any agricultural production from the landscape.

But it seems possible we could devise a landscape with a few salty patches in it and which would be sustainable in the long term.

It's possible in theory to go back to the way things were 200 years ago, but in

practice it's impossible. What we're searching for is a new sustainable system, and in both dryland and irrigated agriculture, the new sustainable system will have salty patches in the landscape, just as the Australian continent at times in the past has been more saline than it was 200 years ago.

Each farming unit ought to have its own evaporation basin so you can concentrate the drainage water, and then it's stored in the groundwater system, which is where the salt used to be stored. So that the salt which is mobilised on farm will be managed on farm.

Let's talk, for example, about the Murray-Darling Basin. We've got marginally less salt in the basin now than we had 200 years ago. But what's happened is the distribution has changed. So our only alternative, certainly in irrigated agriculture, is to store that salt in the groundwater from whence it came.

What criteria do you use to decide what sort of landscape we should have?



Graham Allison: salinity "almost certain" to get worse

Agricultural output, disruption of social frameworks, the environment – there's three to start with. I just don't think it's feasible to revegetate a whole stretch of southern Australia.

Are algal blooms predictable?

Only in the broader sense. We can say that with certain phosphorus and nitrogen levels, and certain flow and temperature conditions, there is a likelihood an algal bloom will form. We are not yet clever enough to predict them. It would be good if we could.

Two of your fellow water scientists, Thomas and MacLeod, recently argued that "there is now considerable doubt whether existing (urban water) infrastructure" – that's water supply, sewerage, drains, etc – "can cope with projected demands". Do you think there's a danger that water quality and quality of water services will decline in the future?

With the water infrastructure, I think there's a real concern it could. It's getting old and we're not investing sufficiently

in its depreciation.

What has to be done?

We really need to have a rethink how we manage our urban water system. The capital involved in water infrastructure across Australia is absolutely enormous – over \$80 billion. The question is does Australia have the capacity to service such an infrastructure?

Is our management of the system inefficient?

No, that's not the issue. Technology has changed since the infrastructure was put in – up to 100 years old. There are now new opportunities, like

much more efficient sewage treatment plants. On the sewage treatment side, we spend something like 80% of the total cost of treatment just on transporting sewage to a treatment farm and only 20% on treatment.

So, instead of having one or two mega-sized treatment plants per city, as we have now, an alternative might be to spend a whole lot less on transport: not have three-metre pipes but only 300-mm pipes going to your neighbourhood sewage treatment plant. You might spend a lot more on treatment per cubic metre, but you would produce much higher quality wastewater, which you could use locally or put into the local stream.

What about private sector assistance?

That's happening now. The water treatment plant in Sydney, for example, is a consortium. The private sector is getting very involved, as it did in Britain and France a few years ago.

Is water underpriced in our major cities?

I suspect things like the cost of environmental damage and some of the long-term lost opportunity costs are not written into water pricing, but it's not an area I have studied. Certainly it's claimed for the Hunter Water Board, as an example of a small water authority, people do pay the real cost of water.

What about Canberra's state-of-theart sewage treatment system. Could other cities be expected to afford the cost to match Canberra's quality of treatment?

We can pay for anything if whoever is running the treatment plant can get people to support it. That plant removes or plans to remove something like 40 tonnes of phosphorus a year from the water. The water eventually finds its way to the Murrumbidgee. It could well be better to remove those same number of tonnes of phosphorus from elsewhere in the Murray-Darling system.

So we have to be careful to look at the total system. As a good example of what I'm talking about, one might consider a sewage treatment plant for a small inland city which puts all of its treated effluent into a stream in the Murray-Darling Basin and then, a kilometre downstream, most of that water is then removed for growing cotton. One could wonder why you would want tertiary treatment of the city's effluent.

Why would you want to spend a heck of a lot of money upgrading the sewage treatment works for that city, if you going to remove most of the water for irrigated agriculture? So you have to look at the total system and where it's best to treat the water.

How do you devise an overall plan to ensure all these issues are identified and an optimal solution arrived at?

Well, just as an example, there is now a salinity and drainage strategy for the Murray-Darling Basin. A few years ago, the states agreed there ought to be a standard set at Morgan in South Australia that the concentration of salt in the

"Perhaps the most environmentally benign way to treat sewage effluent is to minimally treat it onshore, and allow the environment to treat it offshore."

water should not be higher than an agreed level. Then the states got together to work out the best way to achieve this level of salt in the river at Morgan. They asked, where are we going to have the greatest impact for dollars invested on the salinity at Morgan?

It turns out that a major impact would be had by expending dollars at a place called Woolpunda, not far from Waikerie in South Australia. It was decided to take highly saline groundwater out of the aquifer there. This then enabled further development of irrigation in NSW because they could trade the salinity credit.

We're already doing that? Trading salinity credits up and down the river? Yes. Well, between states. And the benchmark is the concentration at Morgan.

Would you see that strategy as a model for other water management issues?

I think it is. Because it's really looking at the system as a whole.

So you say we are already dealing with salinity in the Basin from a whole-systems approach?

Yes we are, and it's working. The problem is that when this strategy was set up, there were some sources of salt which were not taken into account, and that's salt that will come from areas susceptible to dryland salinity. That could be a very large body of salt. But this doesn't mean we should throw the strategy away.

There's also an algal management strategy now being devised for the Murray-Darling system, which mainly deals with phosphorus.

That's much more complex. Phosphorus is conserved, but over what time scale? If I put a gram of phosphorus into the water near Canberra, it might take a couple of million years to come out of the river system. Salt, on the other hand, moves through the system more or less with the water. Nitrogen is even more difficult than phosphorus because there is a whole heap of transformations that occur.

As you're a researcher, I should ask you if water research in Australia is occurring the way it should? Isn't it too fragmented between agencies?

I can see much better collaboration now than there was five years ago, and I think state agencies and organisations like CSIRO are working together much more closely

What is tending to happen is many state agencies are reducing their research activities, and CSIRO and the agencies are getting closer together in terms of delivering the research needs of the agencies.

Going back to the subject of Perth's water, that city's problems are extraordinary, are they not?

It's a difficult situation, certainly. However, there are significant and deep – and for 'deep' read 'well protected' – groundwater sources possible. There's a deep aquifer that's scarcely been tapped

beneath Perth. The shallow water system is what's being used now, and this is the one that's under considerable pressure from contamination. Groundwater quality is an important issue for Perth, and they will have to continue to protect shallow groundwater. In terms of quantity, it's probably not a disaster.

The big issue is the protection of surface catchment water from salt, and that is a very difficult issue.

What then are their prospects?

Eventually one will come up against a wall, and that wall will be defined either by the amount of water available or by the cost of delivering water. Getting water from the Ord River would provide a lot of water for Perth but the cost of building and operating a pipeline is enormous.

The city also has 160,000 septic tanks.

There are some data suggesting that shallow groundwater is more contaminated beneath septic tanks than in areas where there is deep sewerage.

An obvious question: if the Sydney Olympics are going to be the 'green Olympics', what are the water and sewage problems Sydney needs to solve in the next few years? They have got problems, haven't they?

One of their greatest problems is stormwater. There is some evidence that contamination of the coastline from stormwater is worse than from the deep ocean outfalls.

Urban run-off is fairly toxic.

Yes. There's a whole range of metals, hydrocarbons, human effluent of various sorts — one of the things that happens during a storm is that sewers overflow because of illegal sewer connections.

Ocean outfalls are the Australian way of getting rid of waste. Are you suggesting that is right and proper? I'll answer that by saying firstly, this is not my field of endeavor. But I will say that some senior researchers in the UK – I won't identify them – have said that perhaps the most environmentally benign way to treat sewage effluent is to minimally treat it onshore and allow the environment to treat it offshore.

Out there where we can forget about it?

"Salinity is the great sleeper. We have got probably another 1000 to 2000 years before the changed hydrology brought about by land clearing over the last 150 years reaches a new steady state."

No, but it means that if you have good mixing then the environment will treat it. The alternative to that is to use high amounts of energy treating it onshore. Surely what we're interested in is the total environmental degradation resulting from what we do, including the cost of producing the energy, the carbon dioxide generated, etc. We really need to think seriously with a whole lot of waste issues about the most appropriate treatments in terms of total – underline total – environmental cost.

So you're saying ocean outfalls, perhaps better designed than the ones we've got, might still be the best solution?

Indeed, could be.

But hasn't Sydney got a sewage disposal problem?

The public perception is that sewage is a problem, certainly. I'm not close enough to the data from the ocean outfalls to know whether or not sewage is a problem. CSIRO Oceanography are doing some work with the Water Board on this.

Earlier, you mentioned new technological opportunities. CSIRO owns the patents for an interesting constructed wetlands system for treating water. It's basically a pile of gravel, isn't it?

A pile of gravel with plants growing on top. You feed wastewater or sewage effluent into the bottom, below the root zone, and you get vertical flow up through the gravel. It's being trialled with septic tank effluent and primary settled sewage – that's raw sewage with the big stuff taken out. We're had a number of pilot scale exercises but there's still quite a lot of research to be done.

What potential advantages does it have over conventional treatments? Lower operating costs. It's a biological system and yet doesn't have the pongs associated with conventional sewage treatment systems.

There are possibilities for single households and for smaller communities where the price of land is not a big issue. One of the problems we seem to be running into is that it's not showing as much capacity for removing phosphorus as we first hoped. It showed great promise initially in some of the laboratory studies, but that hasn't really been borne out yet.

Are there any other bright new prospects for sewage treatment or disposal? I notice the Japanese have demonstrated a method for turning sewage into food.

That will take a while to catch on. With treatment of the liquid waste, I think what we really need to be looking at is irrigation technology.

There is a lot of research going into land disposal and there are many issues associated with it. One is storage during periods when rainfall is greater than evaporation. Two is the contamination of groundwater, and three, contamination of any surface water that might run off. There appear to be some opportuni-

ties for growing crops such as trees, which are harvested. Of course if you don't harvest, you won't get rid of phosphorus.

The other thing to look at is establishing a system that stores water in winter in southern Australia, when your trees aren't using much water. One way of doing it is to have a system where you store water in the groundwater. You keep putting your sewage effluent on throughout the year, and then during the summer, when you have high evapotranspirative demand, you pump from groundwater. If you adopt the right pumping strategies, then you don't get contaminated groundwater moving off site. So you are setting up a little cell whereby you're removing nutrients and other nasties from your water on site. That seems to me something worth looking

Is that research being done?

There is some research being done at Wagga by a group from different CSIRO divisions in conjunction with some NSW authorities, and we are about to start a little exercise in Griffith, NSW, looking at annual cropping and storage in groundwater rather than surface storage over the winter.

Your general attitude seems to be that you do not consider our water problems to be intractable; in fact you seem quite optimistic about fixing these problems.

I don't think there's any doubt these problems are fixable. They are enormous problems which can be solved. I think salinity is the big issue.

Why salinity above some of the other issues?

Because salinity is the great sleeper. We have got probably another 1000 to 2000 years before the changed hydrology brought about by land clearing over the last 150 years reaches a new steady state.

There's still a big slug of salt coming through the system?

Watertables are still rising, and there will be more landscape salinisation, although the landscape salinisation doesn't worry me. That may sound blasé but it's not. What we have got is a changed landscape, but I believe it will be sustainable.

What does concern me though is that

"There will be about a million more cows in the Murray-Darling Basin in about a decade. Now that's about equivalent to to million people or three Sydneys in inland Australia."

all these dryland areas subject to dryland salinity are draining into our major river systems – for example, the Murray – and we really haven't quantified how big that impact is going to be. Maybe we will be safe, in that we'll only get significant amounts of salt leaching in during flood times. If that's so, then it probably doesn't matter, because it's concentration we're worried about, not load.

Then how bad could it get?

I can't answer that properly. In terms of tonnes of salt going into the river, it could increase to several times what it is now, but that, I repeat, is the load.

It will almost certainly get worse, but we don't know when some of the salt from dryland saline areas will get into the river systems.

It could be the once in 50 years flooding event – like those in Victoria recently – that washes a lot of this salt out of the system into the Murray. If that's the case, then you get high loads, but at a low concentration because you have a heck of a lot of water.

But if you have saline water constantly flowing into our river systems, then we have a very serious problem – like we're seeing in WA's coastal streams, such as the Blackwood. Many of them are very saline, and with those catchments that are used for water supply, the water authorities have decided that the only way to manage them is to return the landscape to what it was like before.

A final topic: feedlot farming. Your division seems to very interested in the consequences of feedlots.

Yes, we are interested. One of the reasons is that, according to a projection made some years ago, there will be about a million more cows in the Murray-Darling Basin in about a decade. Now that's about equivalent to to million people or three Sydneys in inland Australia – primarily due to feed-

There are significant waste and water-quality issues if you are going to have that level of nitrogen and phosphorus put into the Murray-Darling system.

Taking a broad environmental view, should we have feedlots at all? At the moment, we don't have a huge amount of feedlot farming, but of course it's growing.

I would want to look at the benefits, social and economic, to Australia before I decided whether the potential environmental downsides were significant.

Do organisations like CSIRO ever say 'we could fix this problem but maybe the problem shouldn't be occurring in the first place'?

In other words, we ought not do something.

Yes.

From time to time we develop position papers, and we try to lead community thinking on things like this and raise issues. But it's very dangerous for us to try to set policy, and if we did, we would get our heads kicked very quickly indeed.

SUSTAINABLE DEVELOPMENT

Peter Cullen

LUE-GREEN ALGAL BLOOMS in rivers and lakes are a symptom of eutrophication, which is a rise in plant nutrient levels sufficient to deplete the oxygen levels in the water, and consequently render the water uninhabitable for fish and other aquatic animals.

The algae which grow in eutrophic water sometimes produce toxins which can poison livestock and injure humans who drink or come in contact with the water. Much of the Murray-Darling river system is regarded as eutrophic and the algal blooms which occur there occasionally turn toxic.

Phosphorus (P) is a plant nutrient which scientists see as the key to controlling eutrophication. A study of the Murray-Darling Basin in 1992 by an engineering consultancy, Gutteridge Haskins & Davey, indicates that in dry years, most of the phosphorus entering the river system is due to sewage from rural towns and cities. In wet years, most of the phosphorus comes from agriculture (see Table below).

Under dry conditions, 64% of the phosphorus entering rivers is due to treated sewage and stormwater from rural communities. On average these communities contribute 35% of the

phosphorus. Some two-thirds of the phosphorus from humans enters the Basin via septic tanks. Studies in NSW suggest that half of the septic tanks are not working properly due to poor maintenance.

Phosphorus in detergents is responsible for about 30 to 50% of the total phosphorus in sewage, and some scientists and engineers advocate a ban or at least an upper limit on phosphorus in detergent. The NSW Government recently asked detergent manufacturers to limit phosphorus in detergent to less than 5%.

Phosphorus inputs to the Murray-Darling (tonnes/ year)

Source	Dry Year	Wet Year	Av. Year		
Sewage Treatment	500	500	500		
Urban Stormwater	55	125	80		
Non Point Sources					
Irrigation Drains	105	255	165		
Forest	45	850	220		
Pasture	75	1550	360		
Crops	80	1850	360		
Total	860	1685	5130		
Source: Gutteridge Haskins & Davey (1992).					

Some detergent makers claim that phosphorus-free detergent is less effective and costs more to produce. A recent evaluation by Choice magazine found a phosphorus-free detergent the most effective and cheapest among those tested.

Opponents of a phosphorus ban also argue that substitutes for phosphorus in detergent (such as polycarboxylic acids) do not biodegrade rapidly and may have an adverse environmental effect.

Among the claimed benefits for a ban on phosphorus in detergents are:

- A reduced need for upgrading sewage treatment plants to remove phosphorus from effluent;
- Less phosphorus from septic tanks.
 Overseas studies suggest a ban could cut phosphorus in septic tank effluent by half;
- Cheaper sewage treatment. Some research suggests that the cost of sewage treatment would fall if there was less phosphorus in sewage.

Some researchers believe a ban on phosphorus in detergent would cut phosphorus inflows to the Murray-Darling Basin by about 300 tonnes a year, about 17% of the inflow in an average year, and up to one-third of the

inflow in a dry year. This would be a significant reduction and could be expected to lower the frequency and severity of algal blooms, although it would not eliminate the problem.

This article is an edited extract from a paper presented at the Horizons of Science Forum *Land, Water and Life* organised by the Centre for Science Communication at the University of Technology, Sydney.

Below: Flooded pasture. In wet years, most of the phosphorus comes from agricultural runoff.



PHOTO, LINDSAY STEPANO

The facts on

phosphorus

(and algal

blooms)

Brett Wright

Solutions in the pipeline: a case study



PHOTO LINDSAY STEPANOW

Removing nutrients from waste water is a priority if we are to protect our rivers and streams.

USTRALIA'S TOP SEWAGE TREATment plant is as good as any in the world but its operators say it can and must do better.

Canberra's sewage treatment plant is widely regarded as the most advanced in Australia, in fact technologically the equal of any sewerage works in the world that discharges to river or sea.

The Lower Molonglo Water Quality Control Centre, west of Canberra, treats 33 billion litres of sewage a year, and typically discharges effluent at a standard high enough to support aquatic life, which is many times cleaner than the treated effluent discharged by Australia's coastal cities into the environment via ocean outfalls.

The need for high-quality discharge is obvious: in dry periods, the wastewater from the sewerage works may be a

major part of the flow in the Molonglo River, which in turn flows into the Murrumbidgee River.

The discharged wastewater from Canberra therefore has the potential to significantly affect one of the chief arteries of Australia's premier waterway, the Murray-Darling system. In contrast, a coastal sewerage works has the relative luxury of being able to discharge directly into the sea, where the effluent is quickly diluted many times over.

Nevertheless, despite its high technical standards, the Lower Molonglo plant, which is operated by ACT Electricity and Water (ACTEW) is not without its problems. Due to limitations in its capacity to meet demand at all times, the centre's operators are forced on occasion to release partially-treated sewage into the river. These bypasses, as

they're known, have occurred at an average rate of six a year.

The sewer sludge resulting from the treatment process is another environmental issue. At present, the sludge is burnt in furnaces, producing 5000 to 8000 tonnes of ash a year, most of which is trucked to the West Belconnen tip.

The plant is only marginally profitable in pure economic terms, with operating expenses in 1991/92 of \$37 million a year (or \$367 a year per sewered property), compared with an annual revenue of \$41 million. That represents a pre-tax surplus of just \$4 million on an asset base in excess of \$400 million. The plant spends 30% of its operating budget on electricity and the large quantities of chemicals needed in the sophisticated treatment process. Given that ACTEW expects to invest \$1.5

billion on capital improvements and maintenance (for water, electricity and sewerage) in the next two decades, the rate of return on its investment in sewage treatment may be too low.

To deal with some of these problems, ACTEW in 1991 commissioned an independent environmental audit of the Control Centre. The audit – which confirmed that the Centre produced the best quality effluent of any plant in Australia – led to the development of a 10-year \$100 million environment improvement plan (EIP) aimed at minimising the impact of Canberra's wastewater discharges.

Among the EIP's initiatives is a 100-megalitre storage dam to receive flows that exceed plant capacity. The dam, which is now under construction, is expected to reduce the frequency of bypasses to less than one in every six years. More than \$12 million will be spent on improved phosphorus and suspended solids removal and systems for the removal of nitrogen from sewage.

An ash-pelletising plant will be installed in order to produce a range of

commercial products from sewer ash. At present about one-third of the sewer ash is used as a soil conditioner. The objective will be 100% reuse. About \$25 million will be spent on a pilot facility designed to encourage the re-use of treated effluent.

ACTEW is raising about a quarter of the money needed for the EIP via an environmental works levy on households for five years. The rest will be met through sewerage charges. The authority will also introduce a volume-by-charging scheme for non-domestic users.

Sustainability flows from the field

ANAGING HUMAN impacts on the environment in a demands effective control of information from the field, especially in the use of maps and monitoring facilities. Computer- integrated Geographic Information Systems (GIS) are providing water and electricity authorities, planning agencies and local councils with new tools for environmental management. In forestry, for example, it is now possible on computer to graphically combine on age of trees, logging licences,

access roads, regrowth rates and planting programs. The integrated information can then be quickly and efficiently used to ensure forest resources yield the best financial returns without threatening the environmental viability of the resource. Similar GIS facilities – which typically combine field data from a range of sources and display them graphically by location – are being employed in the management of irrigation water, mining operations, power grids, and rail transport networks. According to Mr Brian



maps of timbered areas with data MITS' award winning real time, spatial MODDL.

Burley, a senior executive at MITS, an Australian-owned systems integration firm, the graphic presentation of complex data is proving a powerful tool for planners and managers, allowing them to identify overall trends, as well as 'call up' detailed information on a particular geographic region or locality. MITS recently won an Australian design award for an advanced electronic monitoring and display system. Known as MODDL, the system has been installed on Melbourne's Yarra River and tributaries to provide continuous real-time

data on water flows, allowing accurate forecasting of river height and possible flooding along the Maribyrnong River. The computer-integrated system measures downstream water flows and tidal movements in the mouth of the Yarra, and combines the data to give highly accurate information on water levels and clearances for barges passing under traffic bridges.

The system has the potential to be linked with automatic sampling and testing of water quality, which could be used to immediately alert the Environment Protection Auth-

ority or riverside industries of a sudden change in water quality. MODDL allows early identification of trends, and provides 'event histories' of a particular incident or performance analysis of a range of elements in a whole network. MITS claims the system, which has been purchased by a number of Australian utilities, will bring substantial change to the management of public utilities and transport networks by improving operating efficiencies and capital works spending.

-Brett Wright

Biodiversity in the balance

We are losing links in the chain of life. Humans need a planet on which to live but do they need a biologically rich planet? The answer is yes. Maintaining the diversity of genes, species and ecosystems is essential to the sustainability of agriculture, forestry, fisheries, and human life. Biodiversity is declining in Australia, due chiefly to the clearing of land and exploitation of waterways, and Australian birds appear to be among the worst hit. The rate of decline demands urgent decisions on how we use the continent's ecosystems in future. If we choose to turn back the tide of extinction, Australians need to grow in knowledge at the expense of population numbers and material wealth.

N 200 YEARS OF EUROPEAN SETTLEment, more than half of Australia's forests and 60% of woodlands have been cleared or severely degraded. A consequence of this degradation is the extinction of species and the loss of biological diversity at regional and national levels. The scale of degradation and loss of biodiversity places national efforts to achieve sustainability in agriculture, forestry and fisheries at risk.

Twenty-two species of mammals (nearly one in 10 of the continent's mammal species) are extinct and another 40 species are threatened with extinction. The loss of mammals is the highest for any continent (only 1% of the world's species of mammals have become extinct since 1600) and illustrates the difficulties the nation faces in conserving its native plants and animals.

Among birds, one species – the paradise parrot – is known to be extinct, and throughout southern Australia more than half of terrestrial bird species have declined in abundance. On one estimate, at least 30 of the continents 180 species of frogs are threatened and one is extinct. It is only the lack of information

that prevents similar analyses for reptiles on a national scale. Of the 230 species of reptiles in New South Wales, 5% are endangered, as are 16% of the State's 69 species of frogs.

The status of insects cannot even be estimated, as recent collections show that most invertebrate species are unknown to science. In a collection of 45,000 individual insects and spiders from a site near Sydney, comprising more than 1000 species, more than 90% were undescribed. Many of these species were represented by only a few individuals suggesting that extinction rates among insects could be high as habitats are cleared or otherwise modified.

The story is no different for plants or aquatic ecosystems. More than 3,000 or one in seven of the continents vascular plant species are listed by the Australian Nature Conservation Agency as rare or threatened. Ninety-seven of these are presumed extinct. One species of freshwater fish, the Lake Eacham rainbowfish, is extinct in the wild and, according to the Australian Nature Conservation Agency, 8% (18 species) of the continent's freshwater

fishes are threatened with extinction.

It has long been recognised that Australian wildlife has been severely affected by European settlement, but the extent of the impact and the long-term threats to continental biodiversity have been generally underestimated.

At a conference of the Australian Ecological Society held in 1988, Leon Lim and I argued there had been a massive decline in the abundance of Australian birds during the past 50 years. For example, of Australia's 53 species of parrots, studies by the Royal Australasian Ornithologists' Union had shown that half had declined in abundance since 1900.

Lim and I showed the decline of birds was greatest in southern Australia, but we also presented evidence that birds in northern Australia, such as the Gouldian finch, were also affected by European settlement. The pattern of loss was consistent across Australia and had occurred so rapidly that we predicted the rapid extinction of bird species throughout Australia in the next few decades. In my view, as many as 100 species, or a fifth of Australia's terrestrial



Soaring symbol of biodiversity: The Wedge-tail eagle was long – and wrongly – considered a lamb killer and shot in thousands before its dwindling numbers made it a protected species. Inset: Wedge-tail chicks.

avifauna, are threatened.

Such a loss would be a terrible indictment of the way we treat the continent and the planet. The views presented by Lim and myself were considered extreme, but I now argue that, if anything, we were too conservative and failed to appreciate the full extent of the problem.

New studies have confirmed and extended our conclusions. In a recent survey of the terrestrial birds of Victoria, Doug Robinson found that 71 out of 191 species not considered threatened had either become locally extinct or were declining in abundance throughout their distribution. Other studies have reported that nearly 30% of bird species in semi-arid and arid regions of Australia have declined in abundance. The figure is 60% for the wheatbelt of Western Australia.

In New South Wales, more than 100 species, including one in five forest and woodland species, are considered endangered by the NSW National Parks and Wildlife Service. Twelve species are extinct within the State. Based on counts of birds at 390 woodland sites on the northern tablelands of New South

Wales, Geoff Barrett from the University of New England concluded that, of the 120 species of birds recorded, only 16 could be considered common and not threatened by changes associated with farming and grazing on the tablelands. In a review of the status of Australian birds for the Australian National Parks and Wildlife Service, Stephen Garnett concluded that threatened species in different parts of Australia were declining at a rate exceeding 1% per year.

throughout Australia are those that nest, live or feed on the ground, those needing tree hollows for shelter and nesting, seed-eaters, migrants within Australia, and nectar-feeders. There is no one reason why all these groups have been affected, but it is obvious that, if half of the land in Australia is degraded, birds that depend on ground vegetation and the soil litter for cover and food will also be affected.

Perhaps the most graphic demonstration of the effect of clearing on birds was shown by Jim Porter, from the University of Queensland, in his study

of rainbow lorikeets in south-eastern Queensland. Porter found a direct relationship between the amount of land cleared and the annual decline in the numbers of lorikeets from the late 1970s to the early 1990s. The lorikeets were affected not only by the loss of hollows in which to nest, but by the loss of flowering trees in which to feed. Other nectar-feeders had also been affected by clearing and their decline illustrates how events in one area can affect populations over entire regions.

Impressions of biologists from South Australia, the Northern Territory and northern NSW suggest a continental decline in the abundance of nectar-feeding honeyeaters, a family of Australian birds with more than 70 species.

The losses are especially noticeable where honeyeaters congregate on nectar-rich flowers outside the breeding season, such as on heathlands near Sydney in winter. There is still an abundance of nectar, but many fewer birds. At first this makes little sense, until it is realised that these birds move seasonally between habitats over a wide area of eastern Australia. It does not matter

SUSTAINABLE DEVELOPMENT

"It is obvious that, if half of the land in Australia is degraded, birds that depend on ground vegetation and the soil litter for cover and food will also be affected."

how abundant nectar may be in any one place, the numbers of nectar-feeders will be determined by the amount of nectar in the least abundant habitat. The honeyeaters visiting Sydney in winter also depend on forests and woodlands further inland for seasonal food sources and as nesting habitat. These forests and woodlands have been extensively cleared for agriculture, with significant clearing occurring in the last 25 years.

It is impossible to escape the conclusion that current land use practices in Australia are unsustainable. The loss of species on the scale being reported for the continents birds not only degrades the quality of human life, but is a warning that we may have exceeded the continents capacity to maintain agricultural production and manage its forests and fisheries on a sustainable basis.

of life on earth. It is more than a concept measuring the genetic wealth of individuals, populations and species. It includes the variety of plants, animals and microrganisms, their myriad communities, and the various interactions between plants and animals and environment which perform essential ecological functions such as the purifying of water, building of soil, moderation of climate and recycling of nutrients.

Humanity and its wealth of ideas, traditions, languages and culture are also part of planetary biodiversity. Biodiversity becomes almost a mystical concept, with the Earth viewed as a single organism with a purpose and meaning. As humans, we belong to the Earth and depend on it for our survival. But does our survival depend on maintaining biodiversity?

Putting aside questions of ethics and our responsibility to other organisms, there are practical reasons for conserving biodiversity. We benefit in a variety of ways from having a biologically diverse world. It provides us with new plants and animals for food or medicine. It is the basis of fisheries and generates wealth through tourism and endless nature documentaries. These are all arguments put forward to conserve the world's plant and animal species. By themselves they should be sufficient reasons to conserve Australia's biological richness.

What is not yet easily grasped is the extent to which ecologically sustainable development depends on the conservation of biological diversity. It may be that with better management, even our greatly simplified agricultural systems, including forest plantations and fish farms, can be productive and sustained into the future. Such a world might be less interesting, but people would be fed and housed and would no doubt enjoy their lives without ever hearing a bird or seeing a tree, much as millions of city dwellers and farmers already live.

The question might be: Do we want to conserve biodiversity? If the answer is 'yes', then what should we do to reverse the tide of extinction and environmental degradation facing Australia as it nears the 21st century? In contemplating this question, bear in mind that, as one of the 12 regions on Earth that collectively account for 70% of the planet's species, Australia has an important role in determining how many of the world's species of plants and animals survive the next 200 years.

Because of the extinctions that have already occurred and the introduction of many alien species, the restoration of the continents original biota and their unique communities that distinguished Australia from other continents is longer possible. A future Australia will need to accept a landscape comprising native and exotic species.

Regardless of the species involved, the renewal of degraded landscapes will require the establishment of relatively complex and species rich (that is, biologically diverse) plant and animal communities. These are necessary to restore ecological functions and are fundamental to achieving sustainability in agriculture, forestry and fishing. The extent of landscape degradation and the loss of biodiversity is such that, in the short- to medium-term, Australians may need to accept a reduction in agricultural production. There will also need to be smaller harvests of timber from native forests and fewer fish taken from our waters. Reduced yields are already being forced upon us by the over-harvesting that has taken place in the past. Reduced production does not mean lower standards of living, but it does mean greater emphasis on cultural and educational development, and less emphasis on material wealth.

EITHER INDUSTRY NOR government understands the relationship between sustainable development and the conservation of native plants and animals. Sustainable development means that development progresses without destroying or degrading the biological wealth of the world. Where development has already degraded landscapes and threatened the survival of species, it is necessary to emphasise the rehabilitation or restoration of biological communities even if this means a reduction in economic growth and production. It is clear from the extent of its degraded lands and waters and the loss of species, that Australia needs to place more emphasis on restoration and less on growth.

Inadequate consideration is being given to the underlying causes of land degradation and the loss of biological and cultural diversity in Australia. Government and conservation initiatives focus on the treatment of symptoms such as endangered species and blue-green algae blooms. Conservation, inevitably, become crisis management. Partly this is a consequence of a mode of thinking derived from a society that emphasises rights instead of responsibilities. A result is a conservation ethic that values wilderness





Left: Breeding biodiversity. As part of a worldwide effort to save the Sumatran tiger, the most endangered of the tiger sub-species. several Australian and New Zealand zoos are endeavoring to maintain genetic diversity in tiger populations through planned breeding of unrelated individuals. This tiger, shown here in Melbourne's Zoo new Asian rainforest enclosure, is one of a breeding pair of Sumatran tigers at the zoo. The pair produced twin cubs in 1990, which have since been transferred under a co-operative species management program to Taronga and Perth Zoos. There are believed to be fewer than 400 Sumatran tigers left in the wild, mainly because of rainforest logging, clearing for agriculture, and illegal hunting. The purpose of the zoos' breeding program is to maintain a genetically-diverse captive population indefinitely, with the eventual aim of releasing some animals into protected reserves.

Above: Return to the wild. The orang-utan is the only truly arboreal or tree-living of the great apes and, like the gorilla and chimpanzee, is under threat in the wild. This young Borneo orang-utan is one of about 100 animals, mainly orphans, that have been returned or in the process of being returned to the wild at the Sepilok Rehabilitation Centre, near Sandakan in the Malysian state of Sabah. The apes at Sepilok are typically orphans, sometimes kept as pets at logging camps or illegally in Asian homes in the cities. The long process of rehabilitation at the centre encourages the orang-utans to lose contact with humans and gradually move into the adjoining forest reserve.

to the exclusion of sustainable land management.

The establishment of a reserve system based on the dominant conservation ethic will not conserve continental biological diversity. Inevitably reserves are located on lands ill-suited for other uses. As a consequence, they sample only a small portion of Australia's biological richness. Moreover, reserves established in this way tend to be small, have long boundaries and become isolated in a biologically degraded landscape.

The static reserve system created in Australia cannot respond to long-term changes in climate, nor can it accommodate ever increasing demands from tourism. Coping with increasing numbers of visitors already poses significant problems for the Myall Lakes, north of Newcastle, while those near urban centres, such as the Brisbane Waters National Park on the Central Coast, are being degraded by vandalism, illegal use of vehicles and uncontrolled pets. Reversal of extinction processes and the conservation of Australia's flora and fauna will only be achieved by the integration of a system of conservation reserves with off-reserve management in the nation's dominant agricultural landscape.

Integration of agriculture and the conservation of biological diversity is basic to achieving ecologically sustainable development. To do this there will need to be significant changes in land management and urban lifestyles. This includes an end to the clearing of native vegetation, the allocation of water resources to nature conservation, a reduction in energy use, and greater controls on the use of fertilisers and agricultural chemicals. No progress in the restoration of biological diversity or in achieving goals of ecologically sustainable development will be made without a reduction in population growth and, in the long-term, it may be necessary to accept a smaller population for Australia.

Ann Maree Nobelius

Aborting the slaughter

As its habitat diminishes, the elephant is paradoxically in danger of breeding itself out of existence. Researchers are looking at ways to solve the paradox with drugs derived from human contraceptives.

HE PLIGHT OF THE AFRICAN elephant is bewildering. Decimated by ivory poaching in the latter part of this century, the elephants now face a new dilemma – reduce your population now or face eating yourselves out of a home within a few years.

Under the direction of Richard Leakey, the Kenya Wildlife Service has so effectively controlled poaching in Kenya that the annual birth rate has increased by 5%. Sadly, this leap in the birth rate has only served to highlight the constant struggle in Africa to find some compromise between wildlife conservation and the demands of a rapidly growing human population.

The ever increasing burden of man on the environment has meant that previously protected areas of Kenyan National Reserves, once the domain of elephants and many other species of wildlife, are being handed over for cropping of maize, wheat and a variety of other primary products. The result has been that the elephants are forced to reduce their range to the few remaining national parks where they will be protected, or else risk being speared and wounded by disgruntled farmers. Many

of these farmers have had their shamba's (small farm plots) destroyed in the elephant's passion for sweet-tasting crops. This conflict between man and elephant was a stimulus behind a major conference on the future of elephants and man, held in March of 1992 in the shadow of Mt. Kilimanjaro at Amboseli National Park.

This meeting of many of the top names in elephant reproduction research resulted in the signing of the Amboseli Accord.

The accord warns that predicted increases in human numbers in Africa and south-east Asia will progressively reduce the habitat available to wild elephant populations, and that the survival of African and Asiatic elephants will therefore depend on the creation and support of elephant reserves and sanctuaries.

The problem is that as wild elephants increasingly congregate in reserves, their numbers will increase. Without some form of population control, they would eventually wipe out the habitat in their remaining range.

The accord concludes: "We are in agreement that periodic slaughter of a proportion of the population is ethically unacceptable, a method of last resort, a fate that these noble, sentient, social animals do not deserve at the hand of man.

"We are therefore resolved to embark on an immediate program of research and development to produce humane methods of elephant population control."

A novel solution was proposed by Prof. Roger Short of Monash University. His suggestion was that we should employ a contraceptive method, similar to that used by thousands of women every year — that is, an orally-active antigestagenic steroidal substance that would cause early termination of pregnancy

At present, the most prevalent and practical form of elephant population control is culling (known as *regulated*



"The problem is that as wild elephants increasingly congregate in reserves, their numbers will increase."

euthanasia), which has a devastating effect on these highly sensitive creatures which, like humans, mourn the loss of their family members and are known to bury their dead by covering the body with leaves and branches.

In parts of Africa where culling is routine, the ivory from culled elephants is traded to "supplement" research and management costs. This practice serves only to perpetuate the demand for ivory and ultimately leads to corruption and continued poaching. Surely then it is far more humane to simply prevent the birth from occurring rather than take a life at a later stage.

It was on the merit of this suggestion that Professor Alan Trounson, deputy director of the Institute of Reproduction and Development's Animal Research Group at Monash University, provided me with funding for three months of independent research into the possible application of antigestagens as abortifacients in elephants.

Laboratory tests included the screening of a variety of different progestational and antigestational steroid hormones, both natural and synthetic, to assess their value as contraceptives and to achieve a greater understanding of the mechanisms of pregnancy maintenance in this animal.

I performed a series of competitive binding studies using a high affinity radio-labelled tracer for the elephantine endometrial progesterone receptor (a protein which helps regulate pregnancy maintenance). The relative affinities of these various steroids for the progesterone receptor was then used to predict their potential potency in the live animal. Having completed the preliminary testing, the next stage of research will be to create a range of urine and faecal bioassays for metabolites of the hormones which control pregnancy. These assays will allow us to non-invasively monitor the reproductive status of wild elephants in the field and assess the success of the contraceptive treatments.

At present funding for this second stage is being raised by the Elefriends Foundation in Britain so that this research can continue.

It would be ironic if the answer to Africa's elephant population control problems came in the form of a hormone developed for human fertility control when in fact elephants would not be endangered if humans could control their own greed and population problems.

Soil degradation and water pollution are Australia's worst environmental problems. Land degradation alone is costing the economy well over \$600 million a year, while in recent years there has been a dramatic increase in the incidence of blue-green algal blooms in major catchments. But the tide appears to be turning, at least in part due to Australia's unique Landcare movement.

Managing land at the grass roots

WO YEARS AGO, A THICK RIBBON of blue-green algae wound 1000 kilometres from Mungindi to Wilcannia, the biggest algal bloom recorded on any river in the world.

More recently, during Easter in 1992, holiday-makers were sent home from a popular dam near Brisbane due to fears over toxins from blue-green algae.

Such occurences are hardly one-off events: for the past four years, the Chaffey Dam in north-western New South Wales has been plagued by bluegreen algal blooms, restricting the dam's potential to supply Tamworth with good-quality water.

At its worst, blue-green algal toxin is 10 times more poisonous than strychnine, and recent research indicates that sub-lethal doses of the toxin cause cancer in experimental rodents. It is little wonder that, according to an Australian National Opinion Poll survey in 1991, water quality is seen by the Australian public as the highest priority issue on the environmental agenda.

The quality of the water in our streams and rivers is a real litmus test of how well the land within the water catchments is being managed. Land degradation is an insidious disease which is threatening to kill Australia.

Part of the response to this threat is the Landcare movement, a rapidly growing grass roots movement for achieving sustainable land management. There are now over 1600 Landcare support groups seeking to change land use practices in Australia. Nowhere else in the world is there a network of community groups spearheaded by farmers that is actually delivering results 'on the ground' to improve soil and water quality.

A typical rural Landcare group is made up of a number of land managers (farmers/graziers) from a locality, although urban Landcare groups are now being formed at an increasing rate. The New South Wales Blue-Green Algae Task Force reported last year that about half of the phosphate entering streams comes from urban sources.

Around 25% of our farmers are actual members of a Landcare group, and many others are individually seeking to adopt sustainable practices to help reduce land and water degradation.

The current rate of growth of Landcare does not appear to be slowing down as the concept of a 'grass roots driven, middle of the road' community action movement gains acceptance with the mainstream farming community.

The National Landcare Program was developed by the federal government in cooperation with state governments and the community. The Landcare groups identify their local problems and can apply for grants of up to \$20,000 to collectively work to achieve solutions to the land degradation problems. It is this 'bottom up' approach which is driving the movement and is a major reason for its success.

A total of \$32 million a year in federal funding has been promised for

the 'Decade of Landcare'. The states and corporate sponsors are also making substantial contributions.

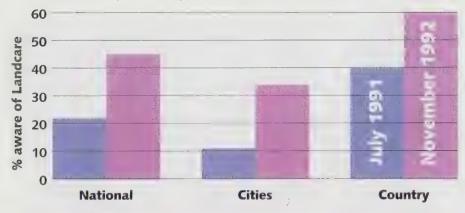
The Landcare group is a basic unit of community action which, through coordinated effort, can solve national and often daunting land and water problems by breaking them into 'bite-size chunks' and finding local solutions.

In the smaller catchments, a Landcare group would ideally contain all properties within the catchment. Each landholder is encouraged to develop a whole-farm property plan to achieve sustainable productivity. These property plans would be integrated to develop a total water catchment plan.

In larger catchments, a number of Landcare groups would form within each catchment. A water catchment plan is then developed using a catchment management committee to co-ordinate the process. Catchment management committees are being formed in most states.

The Landcare group movement provides a model for local involvement in the development of management practices aimed at improving soil health and water quality.

Increasing on-farm vegetation cover based on a whole-farm plan, with trees and improved perennial pastures, reduces salinity, soil loss and acidification. Improved subdivision based on land capability favors the adoption of better, more sustainable management practices. "Nowhere else in the world is there a network spearheaded by farmers that is actually delivering results to improve soil and water quality."



Above: "Before today had you ever heard of Landcare?": results of Morgan Gallup Poll.



Above: Treeplanting. Below: Distribution of land care groups.



For example, the timing and form of phosphate fertiliser application can influence the amount of phosphate which flows from a catchment into rivers and streams. High rainfall events after superphosphate application have been shown to give high rates of run-off, so consideration should be given to applying fertiliser during the drier months of the year.

Salinity is another problem requiring the development of appropriate best management practices. Improved irrigation technology, laser grading, improved water ordering and water recycling all contribute to water conservation.

Keeping the public well informed is an essential part of algal bloom management - individuals can make a difference to water quality by making simple choices in the use of products such as household detergents. Here too, the Landcare movement appears to be working.

Research by Roy Morgan Research Centre Pty Ltd shows that Landcare awareness campaigns, such as the Uncle Toby's Landcare Minute, Landcare Month and the Schools Landcare Video Competition, are reaching the wider community.

The research suggests that between July 1991 and November 1992, awareness of Landcare doubled from 22% to 44% on a national basis, helping to foster a Landcare ethic throughout the community. Significantly, in capital cities, awareness of Landcare increased three-fold, from 10% to 34%.

Our national economy still relies on the quality of our soil to produce the food we eat, the natural fibre we wear, and even the paper for the magazine you are now reading. As well, the quality of more than 90% of Australia's fresh water is affected by the way it moves through and over our soil.

Sustainable land management is the responsibility of the whole community, and the success of the Landcare movement is crucial if our land and water are to be sustained for the benefit of future generations.

NEXT TECHNOLOGY

On a fin and a prayer ... Australia's low-cost push into space





Members of the Ausroc team with the rocket at Woomera (above left). Mark Blair, author of the idea, is second from the left. Smoke billows (right) from the launch pad as Ausroc consumes its load of kerosene – on the ground.

Jon Fairall

The commercialisation of space is opening up a market for small, budget-priced satellites and launch vehicles – microrockets carrying microsatellites. On shoe string budgets, a group of brilliant enthusiasts calling themselves the Australian Space Research Institute (ASRI) has entered Australia in this new space race.

ASRI was formed early in 1993 by amalgamating the Ausroc organisation, a group of amateur rocket builders, with the Australian Space Engineering Research Association (ASERA), a group of amateur satellite manufacturers. Its main project is the Australis satellite, a plan to orbit an infra-red camera for earth observation.

Australis will weigh about 50 kg and will cost just \$50,000 because most of the time and equipment has been donated – at commercial rates, the cost would be about half a million dollars.

It is intended that once Australis is in orbit, amateur radio operators anywhere in the world will be able to contact the satellite, order it to take a picture, and then download the image onto a home computer.

Australis will require a low-mass, low-cost method of stabilisation, a simple-to-use radio system, and a robust control system so that the satellite can operate by itself for extended periods and be immune to damage from enthusiastic but ignorant amateurs.

A group at the University of Queensland is studying a method of using the earth's magnetic field to stabilise the craft, and another group at the Queensland University of Technology is working on the communications system. Australis project director, Craig Lindley, is working on the control system for a thesis while studying for a doctorate at the University of New South Wales.

But what about the launch vehicle?

For the most part, rockets are launched by big organisations in countries letting billion dollar defence contracts or billions of dollars to spend

on national pride. To do it on an amateur basis is almost unheard of.

Which is not surprising. Launching a rocket requires a certain intestinal fortitude. You need to be prepared to risk everything – money, years of hard work – for those sweet few seconds when the motors roar.

Such people do exist. Mark Blair built and flew his first rocket during 1988, while still a student at Melbourne's Monash University. It was small – about two metres long – and it only went up a few thousand metres, but it demonstrated that it was possible for an amateur to design, build and fly a rocket.

Work on Ausroc II began in 1989. Blair gathered around him a team of like-minded individuals who could work on various parts of the vehicle. Dogged by endless searches for money, equipment, test facilities and time, their moment of truth came on the Woomera rocket range in South Australia in October 1991.

Out on the launch pad, there was a stab of flame, but no rocket appeared out of the fireball. Ausroc II was destroyed beyond repair.

The next flight of a redesigned Ausroc II is scheduled for May 1994. It will have improved electronics and valves, a heavier, stiffer casing and three (as opposed to four) fins.

It will also provide a test environment for a satellite navigation package build by Auspace Ltd in Canberra. Ed Roberts, chief engineer at Auspace, says the flight, which involves very high acceleration (about 20g) and vibration, will provide an unusual but exciting test regime.

But why would satellite manufacturers be prepared to risk their work in a small amateur built rocket? The short answer is cost.

Giant, conventional rockets are enormously complex and expensive. With the minimum cost of getting into space presently hovering around \$30 million and the space shuttle at \$400 million a throw, no-one can afford to develop new pharmaceuticals or grow crystals in weightlessness, or take any sort of commercial risk.



New, cheaper routes into space need to be opened up and world-wide people are starting to look at small rockets, and the small payloads that could use them.

A typical communications satellite can weigh one or two tonnes and be as big as a small bus. Some scientific and defence satellites are even bigger. Microsatellites by contrast may weigh barely 50 kilograms.

Graig Lindley says the Australis project is worth-while simply because of the new knowledge it will generate. "Knowledge is the most important product to flow from this venture. The flight will be an empirical validation that our ideas were right."

It will also be an important demonstration that it is possible to do useful work in space for sub-million dollar amounts.

'Fingerprinting' the voice

David Eyre

University of Queensland researchers have developed a system that allows computers to identify people by vocal characteristics. The prototype is one of the first in the world to use what is likely become a common method of identity verification.

Users of the system would provide voice samples for storage. When conducting commercial transactions, for example, they would be prompted to repeat randomly selected key words or phases, allowing their voice 'signature' to be checked against the record.

Professor Tsoi, a leader of the development team, said the handwritten signature was increasingly inadequate in an electronic age and that voice prints are preferable for a range of transactions.

Voice prints can be delivered over a phone and are impossible to forge: "(a mimic) may sound similar", he said "but there are always subtle differences which only a computer can detect".

"We digitise speech and extract features which describe the underlying frequency spectrum, but what makes the human voice unique is unknown – nobody can pinpoint it."

Tsoi's group is the largest in the world working on speaker verification. He said that a number of systems have been developed elsewhere, but these relied upon conventional computing approaches and had failed to provide the level of performance required for complex applications.

What gives his team's system the edge is that it is based on the new technology of artificial neural networks (electrical circuits constructed to reflect some of the learning processes believed to take place in the brain). He said that using machines to identify people by their voice characteristics, has a wide range of potential applications.

"Our system can be used for phone shopping, authorising long-distance phone calls, seeking account details by phone, all with greater security than by conventional methods. Home banking is a major potential market."

He said that the university is seeking an international patent and is in the closing stages of negotiation with a number or providers of ATM machines.

The Networked World – high-tech, low-tech and no-tech

The new local area networks (LANS) are spreading rapidly in North America and Australia, with Western Europe slightly behind. Developing countries in Africa and South America are furthest behind. Eastern Europe is struggling to catch up, and the rest of the world, including Asia, is a mixture of high-tech, low-tech and notech. Japan's Kanji computing system has difficulties operating with Roman alphabets. The fast-growing economies of Asia are expanding rapidly into every level of telecommunications, with China the major wildcard. By 2000 we could see a global network, or two systems - the haves and have

European ISDN contract for Australia

A major contract to supply test and measurement equipment to the European pilot Broadband-ISDN project has been won by Hewlett Packard's Australian Communications Operation.

The pilot project, being explored by 13 countries across the EEC, is timed to start at the beginning of 1994. Broadband technology will allow the simultaneous transmission of voice, text, data and images. It will deliver applications such as high speed data communications, vastly enhanced computer networking, multi-media communications and video telephones.

Green burning

A gas nozzle devised by an Adelaide University research team has the potential to revolutionise global industrial combustion practices, reducing greenhouse gas emissions, smog and fuel consumption in the process.

The new fuel-burning technology is intended for gasfired rotary kilns used for the production of materials such as cement, lime and alumina. Efficiency gains come from better control of gas mixing in combustion resulting in tenfold increases in the transfer of radiant heat and 50% to 75% reductions in oxidisation. There is also a reduction in emissions of nitrous oxide a byproduct which produces photochemical smog, attacks the ozone layer, and contributes to both acid rain and the greenhouse effect.

The technology has won a major development contract and will be marketed world wide.

Artificial intelligence models biodiversity

A new computer program using an Artificial Intelligence algorithm is being used to develop maps of biodiversity. GARP (Genetic Algorithm for Rule Production) uses a form of machine learning to develop sets of rules predicting the presence or absence of species. The program is being implemented in a biodiversity modelling system by the Tasmanian Parks and Wildlife Service. The core algorithm of GARP is called a genetic algorithm because it copies biological evolution by evolving a population of rules over a number of generations. After GARP has developed a set of rules, the rules are reapplied to the environmental data to produce maps of the probability of occurrence of the species.

Water wars threaten as supplies dry up

David Eyre

Wars over water are likely unless international conflict over ownership and management of this vital resource can be resolved. Recent calls for the creation of a UN world water organisation to co-ordinate world water supply reflect the severity of the situation.

World water demand is growing faster than population, largely because of improving living standards. The Western way of life, to which the developing world aspires, is water intensive – for example average per capita water use in the US is more than 70 times that in Ghana.

At the same time increasing population is reducing the average amount of the world's freely available fresh water available to each human.

The result is intensifying competition for the waters of the 200 major rivers that are shared by two or more nations.

Nine of the 14 Middle Eastern countries already face 'water-short' conditions (annual supplies of less than 2000 cubic metres per capita), making this the most concentrated region of water scarcity in the world. Virtually all the region's rivers are shared by several nations and tensions over water rights are a potent political force which could ignite during this decade.

The Ganges and Zambezi rivers are at the centre of bitter disputes.

Recent sudden falls in the level of the Mekong River in Laos have raised suspicions that China may be diverting water upstream unannounced. Low water levels can badly affect agriculture in



Laos, Cambodia and Vietnam, which rely on the Mekong to irrigate their rice crop.

Only about 3% of all the earth's surface water is nonsaline and of that amount, 99% is locked up in the polar icecaps or as inaccessible groundwater. Total annual runoff from the continents is about 41,000 km³. Of this 27,000 km³ returns to the sea as flood runoff and another 5000 km³ flows into the sea in uninhabited areas. This leaves about 9,000 km³ of water available for human use worldwide.

In 1900, only 400 km³ was being used by the world's population. According to UN data, in 1950 worldwide water use was 1,360 km³ per annum and rose to 4,130 km³ in 1990. While it may appear that there remains a fair margin of available water, population and usable water are so unevenly distributed and that supplies rarely match

Average consumption based on availability varies widely: for example, from 5.4 litres per person per day in Madagascar to 500 litres per day in the United States. A common estimate is that

about 80 litres a day is required to support a reasonable standard of living.

Drug companies squeezed

The global pharmaceutical industry is under attack, as governments worldwide seek to reduce their healthcare spending. For the first time the industry is cost cutting. Some argue that a new social contract between the industry and society is needed – showing all customers that medicines are safe, effective and cost-effective. Innovative, valuable drugs will be the key to survival for companies, putting pressure on their R & D.

Asian middle class bulge

The Far Eastern Economic Review reports that between 1970 and 1990, the proportion of those in absolute poverty in most East Asian nations declined from a third to a tenth, even as population grew by 17%. China and

Indonesia reflect the trend most strongly. The Philippines and Thailand are the exceptions. India has shown similar trends in the 1980's, with the current proportion of those in the middle class numbering 100-350 million, and those in absolute poverty about 200 million. In 1977-8, 48% of the population were poor. Now it is 25%. In all countries this means a growing consumer market, eager for better quality goods and food as well as privately owned transport.

Muslim feminists cite Koran in freedom fight

Feminists fighting rising antifemale legislation in Muslim countries are turning away from orthodox human rights arguments and are seeking a rationale for women's rights in Islam itself.

According to the Society for International Development, women's freedom has become the biggest casualty in the Islamic revival sweeping the Muslim world, as regimes impose a traditional vision of Islam on a half a billion women. In countries where 'fundamentalists' have taken power or have seized the social agenda, they have imposed rigid religious laws which severely restrict the freedom of women. As a result, women are rapidly losing their legal rights in Muslim

Some Muslim countries have cited the Koran to legalise polygamy and divorce by repudiation, and to criminalise behaviour such as not wearing a veil, travelling alone, and even driving a car.



Fornication is a capital crime in countries like Pakistan, and according to a Human Rights Watch report, the number of female prisoners in Pakistani jails rose from 70 in 1980 to 4500 in 1990. A rape victim could be accused of adultery or fornication if she makes a report, because to prove the crime the law requires that four adult Muslim males must have witnessed the act.

Many women activists in the Muslim world now realise that the only way to combat such discrimination is to equip themselves with expert religious knowledge — not easy, because religious study has been traditionally a male preserve. Women's groups from across the Muslim world are now coming together to study primary sources of Islam and develop a gender-sensitive interpretation.

UN peacekeeping budget blows out

The United Nations is spending almost as much on peacekeeping operations as it does on social and economic development, a UN Development Programme (UNDP) official has charged. In the last 24 months, the annual peacekeeping budget increased from some \$U\$600 million to \$2.8 billion. The operations now envisaged will bring the annual budget to \$4.3 billion, compared with the \$5 billion spent on economic and social development.

Inge Kaul, director of the UNDP's Human Development Report Office, said the total amount of monies spent on peacekeeping during the last two years alone equalled total

peacekeeping expenditures for 1945 to 1991.

But the 1993 Human Development report argues that it is far better to handle problems early on, when they are less costly though perhaps more difficult to detect. UN Secretary-General Boutros Boutros-Ghali said in April that there had been a boom in peacekeeping operations, "and they will continue to grow exponentially this year".

Third World assault on arms trade monopoly

The Third World is chipping away at the monopoly on the lucrative global arms trade long held by the Soviets and Western nations. Indonesia has just concluded an agreement to sell seven locally assembled Super Puma helicopters to Iran, Argentina has delivered four of its light attack aircraft to Sri Lanka, and Egypt has been selling its Fahd armoured vehicles to Kuwait.

There is a growing trend towards military cooperation among developing countries, particularly visible among members of the Association of South-East Asian Nations (ASEAN). The six ASEAN countries — Brunei, Malaysia, Indonesia, the Philippines, Singapore and Thailand — have accelerated their military links and are increasingly cooperating with each other in defence equipment manufacturing.

The military publication, Jane's Defence Weekly, says Indonesia has a strong military relationship with Thailand, and that the Thai and the United Arab Emirates governments have purchased more than 25

CN-235 trainers built by the Indonesians.

The two major arms exporters to the Third World have traditionally been the United States and the former Soviet Union, followed by France, Britain, Germany and Italy. But during the last few years, several new, non-conventional arms suppliers including Argentina, Brazil, China, Egypt, India, Indonesia, Israel, North and South Korea, Pakistan and Taiwan - have been slowly moving into Third World markets. Industry researchers say China has one of the world's fastest growing military industries, making it the seventh largest arms exporter.

Virtual campus

Virtual learning is now a reality for 230 external students enrolled at Western Australia's Edith Cowan University. The virtual campus allows students to link up with the university using ordinary personal computers - and they can be anywhere in the world. Access is available 24 hours a day, seven days a week, via telephone using a modem and communications software.

Students can join tutorial groups, submit and receive assignments or messages, access library catalogues and 'noticeboards', and 'chat' with fellow students. They can also access AARNet (Australian Academic and Research Network).

Virtual Campus Manager, Ms Jan Ring, said the system was designed to reduce the isolation of distance education students and to improve communication between students and tutors. She said feedback from students using the system had been positive.

"The ability to interact with tutors and other students makes them feel a part of the university," Ring said. "They also praise the system for its ability to give them a quick turn around for problem solving."

Currently Western Australia and Queensland are home to 70% of students on the system, with the remainder spread evenly throughout the rest of Australia and four from overseas (three from South-East Asia and one from the United States).

Many more overseas students are expected to be connected by the end of the year, and there are plans to market the system world-wide for use in education and training.

Population time bomb in the Middle East

The Middle East's rapid population growth could prove destabilising, according to a report released by the Population Reference Bureau (PRB), an independent Washington-based research group. Population threatens to outpace economic growth, strain the region's resource base and upset an already explosive ethnic balance, says PRB.

The Middle East is now the fastest growing region of the world, after sub-Saharan Africa. Forecasters say its population of 265 million could double in 30 years. They attribute the rapid growth to persistently high fertility among people who keep up such traditional practices as early marriage, with women bearing an average of five children.

More drugs could flow from the high seas

Far more new drugs could come from the sea than from the tropical rainforests, because the former contains the greater biodiversity, and searching for new drugs there is likely to be more cost-effective. Already sea squirts, bryozoans (coral animals), sea hares, a sponge, and a red alga are showing strong promise for new cures.

LandcareNet brings farmers on line

A farmer in Cloncurry, Queensland, reads about trees grown for sale by a landcare group near St Arnaud in Victoria on an electronic bulletin board and arranges for the transport of seedlings by exchanging electronic mail with one of the farmers in that group. This would have been unimaginable a few years ago, but modern electronic communications are no longer restricted to citydwellers - a microcomputer and modem are all that rural Australians need to tap into the world.

Through the network, landcare groups can exchange practical information, as well as gaining access to the latest technical information. Users can also tap into the collective knowledge of others by asking specific questions.

Currently in the second year of a three-year pilot project, future plans for LandcareNet include the provision of telecourses (correspondence courses by e-mail); broadening the scope to include other rural issues; and development of an on-line Landcare services directory.

Further information, contact: Janet Hoare; (03) 344 7172; e-mail: janethoare @muwayf.unimelb.edu.au.

Tech-transfer to help China reduce pollution

An Australian engineering company is to install a coal gasification plant to provide environmentally clean coal gas to one of China's port cities. The Warren Engineering Division of PWT Asia/Pacific. based in Melbourne. has been awarded a \$9.2 million contract to provide coal gas to hospitals and 40,000 homes in Yinkou, Liaoning Province, north-east of Beijing.

The plant will be designed in Australia and will use a process licensed by Sirtec-Nigi of Italy. PWT Asia/Pacific engineers will supervise installation, start-up and operator training.

Australia's Minister for Development Co-operation, Mr Gordon Bilney, said that the project would "help reduce the environmental health costs of China's heavy reliance on solid fuels, especially coal.

"Nearly all households in Yinkou use inefficient and highly polluting coal-burning open fires for cooking and heating," the minister said. "The Australian inputs will enable Yinkou to make full use of its gas-reticulation facilities, including 50 kilometres of gas distribution mains."

PWT Asia/Pacific won the contract with the help of a Development Import Finance (DIF) grant of 3.2 million dollars, provided as part of concessional finance arranged by the Government's Export Finance and Insurance Corporation (EFIC).

"Australia's overseas aid program is increasingly using our engineering and environmental expertise to help China overcome environmental problems," Bilney said.

Gasification will help China produce more energy from its coal and dramatically reduce city air pollution.

Cambodian to establish first Environment Ministry

Australia is to help the provisional national government of Cambodia establish the country's first Environment Ministry.

In the wake of successful UN-sponsored election in Cambodia this May, the provisional government has been quick to turn its attention to the protection of the country's natural resources, which have been plundered to fund the war effort. A starting point will be the drafting of environmental legislation and codes of practice, important for regulating the activities of aid agencies and foreign investors attracted to Cambodia since the elections.

At this stage, the newly

established ministry has a minister, Mok Mareth, but very little else in the way of resources. The first priority is to define the direction of the Ministry, and Australia is proposing to provide a specialist advisor to assist with the task.

Deforestation threatens poor

More than 150 million hectares of tropical forests have been destroyed over the past decade, along with their essential resources and lifesupport systems so crucial to many poor nations, warns the Food and Agriculture Organisation (FAO). An assessment of tropical forest resources published by the Rome-based UN body last August puts the rate of deforestation in the tropics at some 15.4 million hectares per year during the period 1981 to 1990.

Australia to host UNIDO clean production conference

Australia will hold a major international conference next year on achieving sustainable growth through the use of clean production processes.

The United Nations Industrial Development Organisation (UNIDO) has asked the CSIRO to host the conference in February 1994.

The conference, which aims to involve Asia-Pacific countries in particular, will discuss topics such as waste



minimisation and on-site recycling, energy conservation, pollution control and technology development transfer.

CSIRO's Chief Executive, Dr John Stocker, said the conference would offer a timely opportunity for manufacturers from around the world to hear how some companies are using cleaner production to achieve the twin goals of saving money and protecting the environment.

"Rapid economic growth in Asia is placing enormous stress on local, regional and global environments. We need to find ways by which this growth can continue while conserving these environments. That is what the search for cleaner production is all about."

The program will emphasise increasing opportunities for international trade in green technologies and services, with industrial site vans, trade displays and sector-specific workshops scheduled.

For more information on the 1994 UNIDO conference, phone (03) 650 6655.

Gopher green facts

Need environmental information fast? Try the Environmental Resources Information Network (ERIN) Internet Gopher information retrieval software. ERIN is available round-the-clock to anyone in the world with access to Internet. Users of the Gopher may browse menus and help themselves to resources including documents, sound and images.

The Gopher software is public domain, may be downloaded via e-mail and is an extremely cost-effective way of distributing environmental information. Since its launch in early 1993, the biggest Australian users have been the Australian National University, the Department of the Environment, Sport and Territories Library and the Australian Nature Conservation Agency Library. International use is growing and ERIN is frequently accessed by the Washington and Lee University, USA.

Most frequently viewed documents include a general ERIN overview, the proposed ANZECC list of endangered, vulnerable and extinct Australian species, a list of data sets available from the ERIN Network, and the Australian Nature Conservation Agency phone list.

For further information, contact Roxanne Missingham on (06) 250 0206 (e-mail: RMISSING@anca.erin.gov.au).

Australian report on sustainable development

The Department of the Environment, Sport and Territories (DEST) is working on Australia's first report to the UN Commission on Sustainable Development.

The report's focus will be on Australia's performance in implementing Agenda 21 items concerning freshwater, toxic chemicals, hazardous wastes, health and human settlements. Australia is committed to implementing Agenda 21 following last year's Earth Summit in Rio.

The report must also review Australia's role in the transfer of environmentally sound technology to developing countries.

Sitting pretty in eco-chair



Rosslyn Beeby

The temperate rainforests of East Gippsland produce some of Australia's finest native timbers, but until recently much of this high-class wood was used for house frames or pallets.

In an effort to boost regional employment, wood-worker Allan Morris set up a wood design course at Bairnsdale TAFE to encourage students to use 'waste' native timbers.

With the aid of a federal grant, he persuaded a local mill to install a special kiln to dry native timbers for use as high grade wood in furniture manufacture.

The region now produces some of Australia's most innovative furniture designers and a chair designed specifically to use waste offcuts of mountain ash (pictured) is one of 10 original designs representing Australian furniture makers at this year's Tokyo Furniture Fair.

Malcolm Thomson was commissioned to design the chair for the Rainforest Information Centre in Orbost, East Gippsland. While working part-time at a local timber mill, he discovered that high quality offcuts produced during the laminating process were going to waste.

Thomson says the offcuts which "were too good to woodchip and too small to serve any practical purpose" were lying around the timber yard as waste.

The laminated mountain ash offcuts form the chair's slatted sling seat, its bentwood arms, and four of the chair's six legs.

Looking for the future in the rear vision mirror

Preparing for the 21st Century

Paul Kennedy

(Harper Collins \$39.95)

As the 1990s wear on and the 21st century approaches, we may expect to see a two-fold publishing boom. One part of it will address the 20th century: what was it about, what are the key themes, what can be learned? The other part will look ahead and ask parallel questions: what are the key trends, what should we be aiming for, how can we achieve a viable future?

Paul Kennedy has produced a book which conforms to neither approach, though he is certainly more at home with the former. He is a generalist with a global view and a broadly historical outlook. The approach he has taken is to provide us with a fairly detailed snapshot of our present or, rather, our recent past. Although the title of the book prominently features 'the 21st century', in fact it is a book about the 1990s. In part one he surveys a number of 'general trends', and in so doing covers much familiar ground, including: the population problem, economic and political change, agriculture, technology (particularly communications, biotechnology and automation), threats to the natural environment and the future of the nation state. So far so good.

The picture thus established is again approached in part two, this time from the viewpoint of 'regional impacts'. Here the uneven working out of change processes on different countries and regions is competently surveyed. The

conclusion reiterates some key points. Two major problem areas are population trends (implying a world of over 10 billion people) and the serious political impediments to effective action. Three areas of policy or action are also identified. There is a key role for education: "the forces for change facing the world could be so far-reaching, complex and interactive that they call for nothing less than the re-education of humankind" (p 339). It is important to improve the position of women, particularly in the poorer nations. There is a need for much more effective political leadership. However, such conclusions will surprise nobody. They are remarkably slight for a book of well over 400 pages. For this reviewer, the book is a disappointment. There are three main reasons.

First, the approach is not original. Over recent decades many generalists (including some highly qualified ones) have trawled through broadly the same territory. The result is a long series of books surveying the 'global problematique' in very similar terms - here are the problems; here are some of the things a reasonable person would do to solve them. Yet this genre tends to be toothless and repetitive. Why? It lacks a critical purchase on the underlying causes of the global predicament. Thus, many well-meaning books end up saying much the same thing. A new writer tackling these same issues in the 1990s should be aware of this background and, perhaps, take a different tack.

Second, it is legitimate to expect that books purporting

to address 'the 21st century' will, in some way, draw upon existing futures literature. For reasons outlined below, this makes it possible to engage with the subject in ways that are both credible and useful. But Kennedy neither uses the literature, nor makes any reference to futures methods. So his book comes across as the effort of an earnest amateur. His intellectual credentials may be impeccable. But a futures writer he is not. So the implied subject of this book remains vague. The view of the future as a kind of 'blank space' about which we can know nothing is not new. It conforms to one of the commonest stereotypes afflicting futures work.

Third, the analysis we are given is largely derived from a reading of external, empirically verifiable trends. This falls squarely into the trap which robbed Naisbitt and his overhyped 'Megatrends' books of much of their legitimacy and usefulness. For the fact is that the so-called 'major trends' that can be observed are largely outcomes, or external expressions of the way we construe the world. I am not trying to be obscure. What has been widely overlooked in the global futures debate is that what counts as a trend does not simply depend upon things, events, processes happening 'out there'. Crucially, it depends very largely upon the prior structures, values, pre-judgements, commitments of the world 'in here'. That is, the world of cultural editing, paradigms of knowledge, epistemological frameworks and, indeed, of worldviews.

Ultimately, then, Kennedy's book achieves little in the attempt to prepare us for the coming Millennium. What we actually get is an up-date on global issues which is certainly of interest, but which falls a long way short of the title. To be fair, the conclusion acknowledges that the book is essentially a "survey" (p 334) which "is intended as a guide to understanding global changes, not as a technical primer for responses to them" (p 337). However, one cannot 'prepare' for something one cannot see. The key question therefore is: how can one see ahead clearly enough to begin these prepa-

The short answer is that it is perfectly possible to construct a broad-brush view of, say, the next two decades, using futures concepts and methods. While in a strict philosophical sense it is true that we can 'know' nothing whatsoever about the future, in practice we can say quite a lot about it which is appropriate and useful. No, we cannot predict future events. What we can do is to study processes of continuity and processes of change. Crucially, however, these should not be seen only in empirical terms. Rather, they must explicitly refer to some of the deeper questions noted above. From such material it is entirely possible to develop a structural overview of the early 21st century. The lack of a futures vocabulary and method means that Kennedy was not able to take this second step. Such an overview will include the key empirical trends (population increase, resource depletion, environmental deterioration etc.), changing ideas (the growth of a stewardship ethic, the implications



of the 'new' science, the benefits of systematic foresight etc.) and, perhaps, the author's views of our progress toward a renewed worldview (if any).

Some of these processes are so massively established that, like the mythical supertanker, they will continue to move ahead with vast momentum. Some are more volatile or even chaotic. Some change hardly at all from millennium to millennium. However, futurists have evolved a range of methods to cope with complexity, uncertainty and unpredictability. So, while a comprehensive overview may test individual writers, collectively the futures field provides a variety of 'maps' of the near-term future. What do these maps look like? Some come in the form of stories (eg. Le Guin's novel Always Coming Home). Some are future histories (Wagar's A Short History of the Future). Some are learned treaties (Berman's The Re-enchantment of the World). Some are accessible and popular books (Moorcroft's Visions for the 21st Century). What do they tell us?

My reading of this material suggests that we are, first and foremost, living in a time between eras. That is, a time when the industrial system, and much of what it stood for (bland optimism, uncontrolled material growth, nature as a resource and so on) has collapsed around us. This view helps to explain the prevailing sense of angst, anguish and fear, particularly among the young. It also accounts for the dominant (largely spurious) view of the future as a dark and forbidding place. What most empirical trend-spotters have tended to overlook is the fact that it is the western worldview which is

in crisis. It is this that drove the rapacious engine of growth. It is this which gave powerful constituencies the apparent right to transform the Earth without thinking through the long-term implications. Now that some of those implications are becoming clearer, we are in a better position to redesign the worldview and reassess our human and cultural commitments.

It is at this level that the

most important work remains to be done. But Kennedy and others who have written in a similar vein, are silent on such matters. They cannot see that, to a large extent, the roots of the future lie in a profound, critical, in-depth view of the present. It is true that this is demanding work. But, then, nothing much was ever achieved in a day. The point is this: if writers want to take up the theme of 'preparing for the

21st century' they should understand the nature of the task. It is a sobering one that requires far more than a survey. A more productive starting point would be to begin with the futures literature itself. It is a rich resource.

Re-stating the problem is not a sin. But a world stranded in the interregnum – the gap between eras – needs something deeper, more original and creative.

Sense of wonder guides view of science



A Promise of Miracles – Celebrating the Scientific Experience

Robyn Williams

Penguin Books \$14.95, 311 pages

Robyn Williams' new collection of 59 short pieces: essays, speeches, interviews, and reminiscences has something for nearly everyone. Here are meetings with famous people, meditations on natural (and unnatural) wonders, rapid excursions through key ideas, and forays into the future.

Despite the pressures of public life ("slithering pile of faxes", endless phone calls and

cardiac arrest) Williams still has a genuine "sense of wonder" about the world. For him science is the great channel through which the latter can be understood and perhaps even preserved. His central mission therefore is to extract from the brightest and the best their special insights and findings — and then make them accessible, especially to the young.

It is a globe-spanning enterprise, and the book reflects this broad approach. Some heavy themes are covered with a characteristic ironic humour. When working on the Snowy River project, he notes that "there was no language to

celebrate nature; it was reduced to some kind of threat to your motor car". William is no stylist - but he does not go for didacticism either. He is never boring, he is never, well, hardly ever, telling you anything. Rather, he enthuses, entertains and, with the lightest of touches, informs the reader. "I am an observer, a reporter of change in society, not a perpetrator or technocrat," he declares. No ego on wheels here. Just an active mind reporting back to its friends.

The book is undemanding and free of abstractions, yet it positively fizzes with ideas. Its central theme however is so understated it could easily be missed. A clue is given in the publisher's flyer where Williams is quoted as saying "only a scientifically aware population can avoid being bamboozled by a spurious promise of miracles and build a scientific culture that will last". Thus, a key question is posed: what part of this promise is spurious? The question is never answered. although it permeates the book. However, a trek through these pages will entertain while providing clues for the attentive reader.

The future of relationships

What has happened to the Romantic Dream – white wedding, children, Mr and Mrs Right, till death do us part? Despite our conviction that lifelong commitment is the key to personal satisfaction and social stability, our relationships frequently fail, usually five to nine years after they begin. Serial monogamy, punctuated by periods of singleness, is the emerging pattern of the '90s, particularly for people under 35. The family unit is reeling from the impact of feminism, women in the workplace, new technology and changing social structures. In Australia today, nearly half of all births to women aged under 25 are ex-nuptial. Increasing numbers of women are deferring childbirth to later in life, or altogether. Fewer than 25% of households now fit the happy family stereotype – male breadwinner, housewife, 2.2 kids.

HE RULES AND THE REALITIES shaping late 20th century relationships have changed.

Since WWII, there's been a massive shift in people's expectations and attitudes towards relationships. As the baby-boom generation hits late marrying and child-bearing age, these children of the women's liberation and individuality era are confused about what they want. Many 'thirtysomethings' are reluctantly settling for less, rather than risking being left on the shelf without children or emotional closeness. Some who married young are now seeking counselling — or filing for divorce. Still others have decided to put career and self before marriage and children, and are opting for a single, independent lifestyle.

Thanks partly to the 'man shortage' scare of the '80s, some still-single baby-boomer women panicked about finding a suitable mate. Latest statistics, however, show that in Australia men now outnumber women in the 25 to 44 year old age bracket, as a result of immigration and the end of the tailing-off of the baby boom – meaning fewer younger women. Now, single baby-boomers of both sexes are having trouble finding mates. Leading introduction agency Yvonne Allen and Associates for example reports that between 1991 and 1993, the number of singles on their books has doubled – and men are just as likely as women to use their services.

However, the '90s outlook is considerably brighter for women 25 to 45 years old than the '80s were, especially for women who don't mind pairing with men of lower socioeconomic status, or younger than themselves. Latest statistics reveal that 41% of Australian women re-marrying choose younger men. It's an option with considerable potential: these couples tend to have high-quality, more egalitarian relationships, better-matched sex drives and low divorce rates. According to recent American surveys, women who marry men around eight years younger than themselves are least likely to divorce.

Statistics world-wide show 80% of divorces occur before the age of 44, so as the baby-boomers reach their 40s, we *may* see more of them settling down in stable relationships. Then again, we may not.

Generation X-ers (the '80s adolescents), have their own attitudes, expectations, fears and problems. Many of these 'twentysomethings' grew up in dual-income families with feminist mothers, and with considerable conflict about gender roles. At least one in three was traumatised by parental divorce and family instability. While 90% of them still want and expect to marry and raise families in the long term, they are sceptical about the chances of marriage succeeding and are at pains not to choose the wrong partner. Hence, most Generation X-ers are putting off the marriage decision till at least their mid-20s, engaging in more serious sexual relationships and de facto trial runs before marrying.

Young people are still having sexual relationships, but they're less likely to be promiscuous than their '70s and early '80s counterparts. The threat of AIDS and sexually transmitted diseases, along with a more conservative, mature approach to relationships than their baby-boom counterparts, means most 'twentysomethings' are looking for

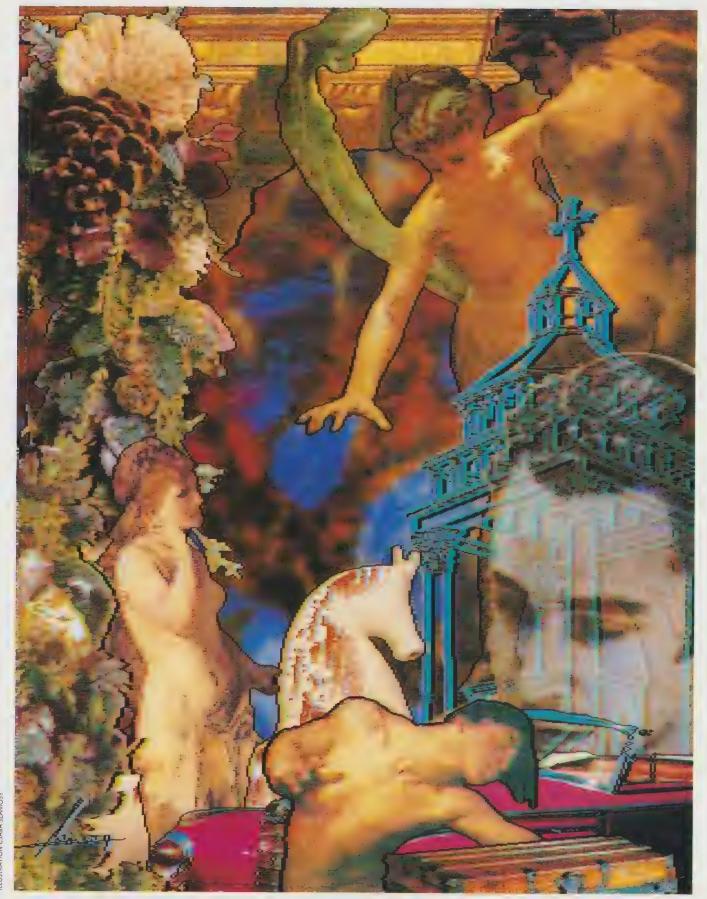


ILLUSTRATION CSABA SZAMOSY

"According to recent American surveys, women who marry men around eight years younger than themselves are least likely to divorce."

serious commitment. The young women who grew up with feminism, working mums, education and career aspirations, contraception, self-help magazine articles and sexual liberation, are more demanding about what they want in an intimate relationship. The young men are more inclined to want to accommodate their partners, but are often confused about how to do it and fearful of inadequacy.

"These days, people expect more out of their marriages, emotionally," says Dr Warwick Hartin, of the Cairnmillar Institute, a Melbourne-based centre for relationship research, training and support. "Over the last 50 years, we've shifted the basis of marriage from an economic to an emotional one, and that's made it more vulnerable."

N THE EARLY '70s, the women's liberation movement had a huge impact on Western women. Feminist ideas helped bring about significant social and political change, as well as changes in individual attitudes and actions, and men and women have been forced to deal with the accompanying alterations to their status, gender identity and power.

"Feminism has transformed the way people relate," says Don Edgar, Director of the Australian Institute of Family Studies (AIFS). "There is now much, much more emphasis on the quality of the relationship." Women, especially, have become wary of entering into any partnership that may take away their autonomy or cramp their style. There is, according to AIFS, "a new imperative on men to work harder at the construction of an intimate relationship... 'love work' [is] increasingly significant in the construction of intimacy."

But few men have been brought up to value or feel comfortable with emotional self-disclosure – thus, most are ill-equipped to cope with modern women's relationship requirements.

According to Susan Gribben, Director of Clinical Services for Marriage Guidance Victoria, "women are demanding a lot from relationships, and the minute their needs are not being met, they're out. They might even prefer the single life, where they can get their needs met from a range of sources."

Even if men lack emotional skills, increasing numbers of them are coming to accept a more egalitarian, participatory approach to intimate relationships. "The more clear and definite women become, the more men will shift," says Kerrie James, Director of Clinical Services for Marriage Guidance NSW. "Women aren't going to give up on relationships with men, but they'll demand change.

And the only way change happens is if there's a *consequence* for not changing."

In key areas, however, feminism does not seem to have brought true equality to relationships, or major shifts in attitudes to relationship and family roles. Women continue to do most of the housework, and although young men are more likely than young women to want children, most still don't expect to play a major childrearing role. A significant number of men still hanker for the 'good old days', when gender roles were clear-cut and males were the dominant partners. "For many men, marriage is a stable base from which they operate in the employment world," explains Hartin. "Men generally expect less of their marriages, emotionally. Whereas for women, marriage is more central."

Neither has feminism significantly changed the attitudes of many young women. "It's the sad truth," says clinical psychologist Dr Bob Montgomery, " that adolescent girls are still inclined to see their value as determined by their ability to get a boy, their role in life as to marry and settle down."

Women, despite their desire for change, may be deeply ambivalent about the power shift equality entails. "Sexual differences are programmed early on," explains James. "As much as many women don't like male dominance and oppression, it's our culture and we internalise it. So it's not easy to change the power balance in relationships."

Feminist ideas are mainly the province of an educated elite, she says. "The less education and opportunity a woman has had, the less likely she is to be a feminist. If a woman doesn't have a career identity, her identity is as a wife and mother and it's threatened by feminist ideas ... But as more women get more educated, their expectations increase."

Men may have been slow to respond to the changing role, status and expectations of women, reluctant to accommodate — even to acknowledge — new relationship values, but the signs are encouraging. "Our research shows men are just as unhappy as women are about the breakdown of relationships, and they're very unhappy about the lack of time they have to give to their families," says Edgar. "There has been a big shift in the last 10 or 12 years."

T ABOUT THE SAME TIME as feminism, there was another development that was to revolutionise modern relationships: in the late '60s effective contraception became widely available, allowing women to control the pattern of childbearing.

"Women in particular are deciding that staying single is preferable to hitching up with an unsuitable mate."

Given choice over reproduction, increasing numbers of women are delaying childbirth, and more are deciding to forgo children altogether.

"The birth rate [in the '90s] is at below replacement level, at about 1.8, and it hasn't changed much over the last 15 years," says Edgar. "That's a function of the Pill, prolonged education, later age at marriage and economic expectations."

According to AIFS researcher Glezer, women today are significantly less likely to see children as an attraction of marriage; nowadays, it's men who are more inclined to marry out of a desire for offspring. Young women value work, self-development and material comforts highly and fear childraising could undermine all three. More women now choose to further their education, careers or personal horizons before — or instead of — starting families. University and TAFE enrolments for women skyrocketed during the '70s, as did the number of women, married and unmarried, in paid employment.

Partly in response to women's demands, more companies are taking family needs into account, for example, by providing childcare services and subsidies, parental leave

provisions, and flexible work hours for parents.

Nowadays, according to the AIFS, women are almost as likely as men to be employed – 81% are in full employment. This newfound independence, along with a greatly expanded set of life options, has made women less likely to focus exclusively on relationships, family and children. The late '70s and '80s saw women taking on the dual housewife-worker role in increasing numbers. In fact, the group that increased its participation in the workforce most dramatically over the '80s decade was married women with school-aged children. In 1970, 32% of married women were in paid employment; by 1990, 53% of married women had joined the workforce, and 60% of those had dependent children.

With two-income families now the norm, men's traditional position as financial controller and head of household has been seriously eroded. "Through employment, women develop skills and self-esteem, find interests and friends outside the family, and attain financial independence," says Hartin. "As a consequence, they have a more powerful role within marriage, and are better positioned to leave an unsatisfactory relationship."

BACKLASH!

VER 30% OF ALL COUPLES who seek counselling have had some form of domestic violence, says Dr Warwick Hartin of the Cairnmillar Institute, Melbourne. "It's a potential that's there in a great many marriages, in situations of conflict. The cause of most violence is frustration, an inability to make the other person understand. It has been said it's a reassertion of male power. I think the opposite is true. It's an indication of male powerlessness."

"We now have increasing numbers of men self-referring, concerned they are violent, and wanting help," says Susan Gribben, of Marriage Guidance Victoria. "I don't know whether domestic violence and child abuse are more common now, but we can say that if some men feel under threat of losing control in their relationships, they may make increasing use of violence."

In Gribben's view, the problem is deep-rooted and difficult to change. "The fundamental societal cause of violence has to do with the disrespect of women generally by men in society, the desire to control and coerce, and the primacy of male values and male ways of doing things," she argues. "At the very heart of violence is lack of equality, and until we tackle that as a society, we're not going to get good relationships."

"A huge part of it is the social sanctioning of men's power over women," agrees Kerrie James, of Marriage Guidance NSW. "If violence becomes abhorrent, and if clear consequences are automatically imposed [on violent men, by law], there'll be no sense of 'getting away

with it'. Then I think men would handle their rage differently."

Are such socio-legal controls enough? Clinical psychologist Dr Bob Montgomery believes training men to control anger is crucial if we are to solve domestic violence problems. "Research shows that domestic violence in nearly all cases is driven by the male, and nothing the woman does makes any difference," he explains. "Until the guy accepts that it's primarily his fault and is shown how to change, he's stuck. Men need to learn how to manage anger constructively and assertively rather than aggressively, to resolve conflicts without having to be physical. That's where you start to worry about our culture's emphasis on an aggressive approach to conflict resolution, and the naive assumption that competitive sport is in some way a model for the rest of life."

"Serial monogamy, with periods of singleness in between, is the accepted pattern of the '90s, particularly for people under 35."

The introduction of the Family Law Act (1975), which brought in 'no-fault' divorce and made it easier and less expensive to dissolve marriages, led to a huge upsurge in the number of divorces. ABS statistics show the number of divorces more than doubled between 1976 and 1991. However, Marriage Guidance NSW reports the Australian divorce rate has been stable for some years at a high 35% (UK divorce rates are around 37%; in the US, the figure is close to 50%). In 1992, there were 45,663 divorces in Australia.

"There's a trend towards people being more willing to get out of a relationship they see as not working," says Montgomery. One in three Australians now believe a person should not stay in a marriage that doesn't allow them to grow as a person – and women are particularly likely to support this notion. According to Hartin, "Women initiate divorces in 75% of cases ... which seems to indicate that women are not getting from marriage what they want."

ESEARCHERS HAVE LINKED high divorce rates to women's employment and consequent financial independence, greater self-confidence, and wider social opportunities. Still other research suggests women's desires for higher-quality relationships and greater autonomy may be critical factors in their decision to divorce.

"Women's entry...into the workforce, plus the financial protection provided by the Family Law Act, Child Support Act and Social Security, even though these are often insufficient, are enough to enable her to leave," explains Gribben. "Women [realise] divorce is going to leave them financially poorer, but they're still going ahead and doing it."

Women may be the losers, materially, but men are the psychological underdogs in most divorces, according to Gribben. "The men that are left often have a major identity crisis."

Not surprisingly, ABS statistics show that fewer Australians are deciding to remarry – more people now choose to live in de facto relationships or remain single once their first marriage fails. Women in particular see staying single as preferable to hitching up with an unsuitable mate. The number of women living alone rose by 20% between 1986 and 1992.

"Increasing numbers of women have a partner but don't live with him," says Hartin. "This is especially true of women who've separated and divorced. They've decided they don't want the aggro and the hassle of having a man there all the time, having to cook his meals and wash his socks."

Latest ABS statistics show that nearly 10% of Australian families were headed by a single adult. Of the 4,638,100 families in Australia in 1993, 416,200 are single-parent, and nearly 90% of these are headed by women.

A substantial number of single parent households are the products of divorce, but some are the result of exnuptial births (which have risen from 9% in 1970 to 22% in 1991). According to ABS, nearly half of all births to women aged under 25 and 81% of births to women aged 17 to 19 are now ex-nuptial. The number of single mothers rose by 30% between 1986 and 1992.

Not surprisingly, there is a strong trend in Australia towards the acceptance – even the expectation – that marriage is not 'forever', however much we might want it to be. Despite our continued expectation that lifelong commitment is the key to personal satisfaction and social stability, our relationships frequently fail, usually five to nine years after they begin.

An Australian Institute For Family Studies has found that while 87% of 23-year-olds either are or expect to get married, most are not prepared to take on the responsibilities of family life until they have reached their individual goals and attained financial independence. Seventy per cent would rather be in a relationship than single, but they also want time for their own enjoyment and personal growth. Members of their generation are big on individual development, and this is increasingly true of women.

Serial monogamy, with periods of singleness in between, is the accepted pattern of the '90s, particularly for people under 35.

"Young people, for all sorts of reasons, are delaying marriage," says Edgar. "Therefore, they experience close relationships with a number of people before they get to the big question." Research shows 'twentysomethings' are replacing early marriage with cohabitation. The number of Australians cohabiting before marriage has risen steadily over the last 20 years, particularly in those aged under 35. Australian figures are even higher than those reported by American researchers.

This trend seems likely to continue, "because the structural conditions giving rise to that won't change", says Edgar. "Young people will continue to need prolonged education, and will be financially dependent for a longer period on parents. Therefore, there isn't the capacity to commit...The main change, particularly for women, is

"Men see mediation as a preferred alternative to counselling; women see it as a preferred alternative to litigation."

that prolongation of the early adult stage opens up new options."

Experiencing a variety of relationships before entering marriage may set up the pattern for serial monogamous relationships, but in the conservative '90s, says Edgar, "there's a strong emphasis on exclusivity. That's partly a fear of AIDS, but it's also greater maturity." Montgomery confirms this. "There's little evidence to suggest girls will hop into bed with anyone," he says. "Recent research shows girls have caught up with the boys — they have more sexual relationships before they settle down, but serially, and they take each one quite seriously. They're also more inclined to bail out of it if it isn't working, even if they're married."

The biological urge to find one or a succession of mates with whom to procreate may also be the reason why we've failed to embrace '70sstyle 'alternative' relationship options, suggests Edgar. "The oldfashioned, hippie-style open marriage has virtually disappeared, basically [because] people are coupling animals, not group animals, and intimacy depends upon having a one-to-one exchange between two people who know each other well. All those group things were proven to be failures. It runs against human nature."

As relationships come under increasing internal and external pressure, more people are turning to professional psychologists, counsellors and self-help books for solutions to relationship problems. The number of people seeking help has risen dramatically over the past three years, and demand for marital counselling and psychological services now far outstrips supply.

Couples today are dealing with an increasingly complex, rapidly changing society and serious outside stresses, such as unemployment and financial hardship. "Economic problems can exacerbate a situation," says James, but "sometimes people *stay* together for economic reasons, because they can't afford to separate. It costs huge amounts."

Relationship counsellors see economic and social pressures on relationships as stressful but in most cases surmountable, given that the couple affected know, or can be taught, how to relate to one another effectively. The solution lies in better communication and conflict resolution skills: there is still insufficient constructive dialogue between the sexes.

Women, traditionally the relationship 'caretakers', are more likely to recognise problems and seek help than men. But often it's a case of too little, too late. "I'd like people to take advantage of counselling at an earlier stage," says

Hartin. "A third of all people seeking help have already separated. They're thinking of divorce before they're thinking of help for their marriage."

Edgar sees it as a problem of social style: Australians just don't go in for therapy. "There's more formal counselling than there used to be, but [seeking help] is an admission there's something wrong you can't sort out yourselves. That's not part of the Australian psyche."

Once couples come to counselling, says Hartin, the 'success rate' appears to be quite good. "Two-thirds of the couples we see stay together, and it's getting better." James agrees. "Where there is goodwill and not a lot of water under the bridge, we can help. But counselling is expensive, so people often leave it too late."

When counselling fails to 'save' a relationship, men are the ones most likely to complain – and shift the blame. "A recent AIFS evaluation of marriage counselling found men tended to be less satisfied than women with the outcome of their counselling," says Gribben. "Whereas women accepted their shared responsibility for the fact it wasn't going to work, men kept on think-

WHERE'S MY CLEAN SHIRT?

ESPITE THE FACT that over half of all married women now work and contribute financially to the household, most men are reluctant to take on a greater share of domestic and family responsibilities to compensate. The majority still leave most basic childrearing tasks to mothers. When they do share in the housework, men's participation is often reluctant, and they frequently over-estimate their actual contribution. Surveys show that even today, women do around 80% of parenting and domestic tasks.

While 85% of young people still expect to have children, the majority of young women intend to continue working after the birth of their babies, albeit with periodic interruptions and parttime work phases. Most young men assume parenting will not necessitate any interruptions to their work pattern, reflecting men's ongoing tendency to view parenting as women's responsibility.

Recent evidence suggests unequal domestic contributions lead to resentment and frustration, and are the overt or covert cause of many marital conflicts. ing there must be some magic solution."

Male reluctance to seek help and lack of satisfaction with relationship support services would probably diminish with the adoption of more 'user-friendly' counselling for men. According to Gribben, "men respond more to talking about relationships in a structured, behavioral, problem-solving way. Women want to understand at an emotional level; men want to understand in a practical way. I don't think the counselling profession has come to grips with that yet. Mediation is far more understood and valued by men. Men see mediation as a preferred alternative to counselling; women see it as a preferred alternative to litigation."

Many modern relationships are kept afloat by the informal, unpaid contribution of extended family members. "The extended family acts as a supporting network in times of crisis. It can provide emotional and material support, babysitting, help in practical ways," says Hartin. Although we're unlikely to see a return to the traditional extended family structure, a new type of extended family may well become entrenched if economic hard times continue.

A number of recent studies have noted a trend for young adults to stay in, or periodically return to, the parental home (sometimes accompanied by their partners) as economic difficulties and prolonged education make independent lifestyles less feasible.

There are also more people setting up 'pseudo-families': the fastest-growing household type in Australia today,

reports market research expert Hugh Mackay in *Reinventing Australia*, is the 'non-kin network' – people with no blood or sexual ties, living together for companionship and security.

Homosexual family units are more socially visible than they used to be, though there's no indication the numbers choosing this lifestyle are increasing beyond the 10% that has long been observed in human and animal communities. "There's a stronger tendency for homosexual people to live together than before," observes Edgar, "but I don't think [homosexuality] is anywhere near as high as people think."

O WHAT DOES THE FUTURE HOLD for relationships?

If current trends continue, more people will live their adult lives in a series of de facto relationships or successive formal marriages; more will remain single, by choice or by default; more will put off having children until their late 20s and 30s, and will choose to have fewer of them; and most of those that do marry will expect a more equal and more intimate relationship than their parents had.

The nuclear family unit headed by a married heterosexual couple will be the preferred but by no means the only lifestyle in a widening network of options that includes de facto partnerships, homosexual relationships, group households, the modern 'extended family' unit (parents, adult children and their sexual partners, sharing the parental home), 'non-kin networks' and singles.

How will these trends affect our relationships in the

QUEST FOR THE SEXUAL GRAIL

LARGE-SCALE MACQUARIE
University study on divorce in
Australia found sexual dissatisfaction was the primary
perceived cause of marriage breakdown.
According to clinical psychologist Dr Bob
Montgomery, "a satisfactory sexual relationship is...not enough by itself, but for
most people it's an important part".

"People expect more out of their sexual relationships nowadays, especially women," says Dr Warwick Hartin, Senior Fellow at The Cairnmillar Institute, Melbourne. "A century ago, women officially weren't expected to enjoy sex — now they officially are." According to relationships researcher Giddens, being able to separate sexuality from reproduction opened up a huge variety of sexual possibilities. More was left to the individual's choice, leading to a revolution in women's sexual autonomy, to increasing sexual experimentation, and to more visible homosexuality.

Sexual problems are also changing, according to relationship counsellors and psychologists. "There's a trend for more women to turn up with performance-conscious problems, which used

to be the men's domain," says Montgomery. "It used to be that the guy was supposed to perform and the woman was supposed to be the passive recipient. Part of the price to be paid for overcoming that problem has been that some women have taken on that performance pressure... With men, it's more common now to turn up with difficulty reaching orgasm, which used to be almost solely a woman's problem, and the most common female complaint."

The main problem seen by counsellors at Marriage Guidance Victoria, says Susan Gribben, Director of Clinical Services, is "lack of sex, caused usually by

21st century? "The negative future scenario is warfare," says Gribben. "Men confused, angry, feeling relatively powerless, and unable to sustain a relationship with women because it's all just too hard; women deciding men aren't worth the effort, having occasional sex only; men living primarily alone, having little contact with women or children; women living with each other, and with children. I see that as a distinct possibility for an increasing number. You'll no longer have men and women working together to create a society."

What we get from relationships over the coming decades depends on what we give to relationships now. Nothing works without directed effort, and what is needed at this critical point in our social history is a concerted push to create the conditions that support what we want and need from relationships.

On an individual level, this means doing more active 'relationship work': men letting go of fears about loss of power; women asking for what they want without aggression; men doing more work around the house; women being more tolerant and encouraging of their efforts. We need more adequate relationship and sex education programs, in schools and for adults; more and better psychological services; more refuges; and more support groups to help people develop relationship skills and overcome problems.

On a wider societal level, it means developing laws, workplace structures and support services that accommodate and cater for a variety of family and relationship structures. Thus we need improved childcare, paternity leave provisions and job flexibility to cater for dual-income and single-parent families; and better household technology and domestic services to help families and couples manage the demands of modern lifestyles. We need revised laws relating to domestic violence, child abuse, divorce custody and maintenance provisions, and divorce and de facto property and assets settlements, to help ensure safer relationships and less traumatic, more equitable separations; and we need to remove the laws that discriminate against non-nuclear families and relationships with respect to employment, insurance, superannuation, child custody and adoption, property rights and housing loans.

If we, as individuals and as a society, can take some or all of these steps, the outlook for relationships is promising. "The positive scenario," says Gribben, "is that we will see more men and women beginning to achieve more equal and deeply satisfying couple relationships, with a greater understanding of the limitations of romance, of the need to work on a relationship and to share the responsibility of working on it; [as well as] more equal sharing of parenting and housework. There has been a big adjustment by men and women, and the possibility is there. The dream of 90% of people, whether they're heterosexual or homosexual, is to find a long-term, meaningful couple relationship. The future of our next generation is dependent on the extent to which couples can relate co-operatively and well."

a reluctance of one partner to put aside time for the relationship. The relationship has already started to disappoint them, so they've started to look for substitute areas. For women particularly, if the relationship isn't there for them, they're not interested in the sex. People say how overpowering the sex drive is — yet how easy it is to turn off!"

Lack of libido is the epidemic of the '90s. But it's not the only problem: other issues seen by Australian marriage guidance counsellors, says Gribben, include "confusion of sexual identity, women preferring oral sex to penetration, out of balance sadomasochistic relationships,

penetration difficult or impossible, sexual difficulties related to a history of incest, and mixed messages about sex in the family".

"If you tot up the emotional and social health costs of sexual problems, they're high," says Montgomery. "So helping people be happy sexually is a serious exercise."

"The problems we're seeing now are more complicated than they used to be," he says. "That's partly because a lot of simpler problems are being prevented in the first place, because we're finally doing *some* honest sexual education." People are also getting more help from maga-

zines, 'pop psychology' books, sex manuals and videos – although the quality of such 'help' varies widely.

The good news is most sex problems can be easily solved. "Psychologists are getting better at recognising the complications," claims Montgomery. "Thirty years ago, the prognosis for someone with a sexual problem was poor. Over the last 20 years, some very good techniques have been worked out, so nowadays, most of the primary sexual problems can be helped; often quite quickly. For a genuine case of premature ejaculation, one session is sufficient in most cases to solve the problem."

The ghostly neutrino

Neutrinos are individually as insubstantial as anything in the universe, but collectively they could form a large part, perhaps even the dominant part, of the matter of the universe. Despite their abundance, they have proved remarkably difficult to detect. Indeed, they are as elusive as they are numerous, and science's sleuths are going to extraordinary lengths, and depths, in an endeavor to trap them. In doing so they hope to solve the mystery of the 'missing mass', and perhaps even the universe's genesis 15 billion years ago.

EWIS CARROLL WOULD HAVE loved the Elementary Particles called Neutrinos. They have fascinated physicists since they were 'invented' some 60 years ago. As a consequence, today scientists in many parts of the world are operating or constructing vast sophisticated detectors deep underground to try to capture the traces of a few of these ghostly particles, which may hold the key to our understanding of the birth of the Universe.

Physicists in the early years of this century faced a terrible dilemma. In beta-decay a nucleus of one element spontaneously changes into the nucleus of a neighboring element in the periodic table, emitting an electron (or sometimes an anti-electron or 'positron'). To their shock the scientists found that some energy appeared to vanish in these decays. Perhaps even worse, sometimes a little energy was 'lost', sometimes all of the available energy disappeared.

The solution proposed by Wolfgang Pauli in 1930 was that the missing energy was carried away by a new particle, so ephemeral as to be undetectable. Many preferred the failure of the law of energy conservation to that hypothesis, and Pauli himself wrote: "I have done a terrible thing, I have postulated a particle that cannot be detected". Twenty five years later Clyde Cowan and Fred Reines proved Pauli wrong (in the above statement) but right (in his postulate) by observing the neutrino.

We know more about neutrinos than sixty years ago but recent experiments have produced more questions than answers. The problem facing experimenters is that neutrinos are almost undetectable. The neutrinos emitted in beta-decay can typically traverse too light-years of lead unscathed. As another example of the neutrinos' tremendous penetrating



Above: A closeup of part of NOMAD. The author is seen examining one section of the detector which is the responsibility of the Australian physicists working on the experiment.

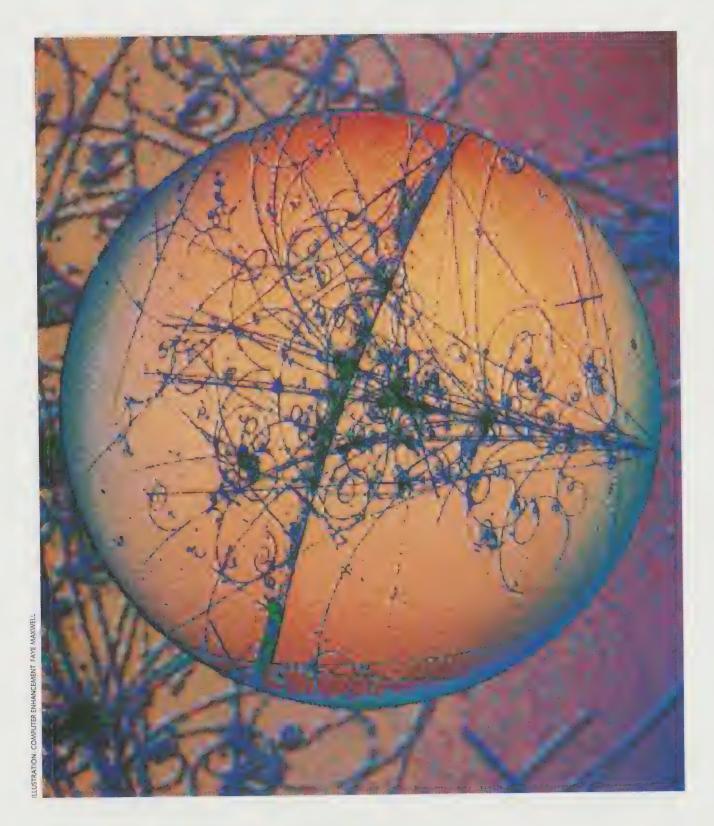
Right: A computer enhanced version of a photograph taken by the Big European Bubble Chamber in which an energetic neutrino strikes a proton in the bubble chamber and creates a 'jet' of some dozen shortlived particles.

power, consider neutrinos from a nearby source, the sun. While you have been reading these opening paragraphs, 1011 solar neutrinos (that is 100,000, 000,000) will have passed through you. That's if the sun is shining. If you are reading this at night the number is only 99,999,999,999; on average one neutrino in 1011 will have interacted during its passage through the earth, the remainder passed through our planet as if it were empty space. That makes experiments on neutrinos quite difficult! As their energy increases they are more likely to interact with matter but that, as we will see later, can be both a blessing and a curse.

What we do know about neutrinos? The basic building blocks of the universe are leptons and quarks. (The latter, which are not discussed here, bind together to make the protons and neutrons of atomic nuclei.) The most familiar lepton is the electron with negative electric charge. The electron has an antiparticle, the positron, with positive charge, and it has two electrically neutral partners. These are the electronneutrino (ν_e) and the anti-electronneutrino $(\overline{\nu}_e)$. This is summarised in the first line of the table on page 102.

As can be seen from the table, nature has chosen to repeat the electron 'family' with two others, the *muon* family and the *tauon* family. The charged muon is a heavy electron, about two hundred times more massive, while the charged tauon is even heavier, about 3,500 times as massive as the electron.

We do not know why there are three



"The problem facing experimenters is that neutrinos are almost undetectable. The neutrinos emitted in betadecay can typically traverse 100 light-years of lead unscathed."

families, but we can now exclude the possibility that more families will be found. At the European Laboratory for Particle Physics (CERN) near Geneva is an accelerator called LEP, for Large Electron Positron Collider. As the name might suggest, high energy beams of electrons and positrons collide head-on in LEP. Experiments at LEP can measure the numbers of neutrino families, and their answer is 3.02 with an uncertainty of 0.04. There must be an integer number of families and four families is easily excluded by that result.

However after sixty years in which much progress has been made, neutrinos are as puzzling as ever. Do they have mass? So far no experiment has measured a finite rest mass for any of the neutrino species; we know only that they are much, much lighter than their charged partners. There is no compelling theory that requires them to be massless; on the contrary several favoured theories require that they have a finite mass. Should they possess mass then an intriguing possibility arises. The electron is clearly different from the positron as they have opposite electric charges, but the neutrino in each family may be identical with the antineutrino in that family. Such neutrinos would be named after Ettore Majorana the reclusive Italian genius, who disappeared soon after predicting them and is believed to have committed suicide.

HICH BRINGS US TO THE solar neutrino puzzle. Life on earth is made possible by the nearby sun and its all-important energy. It takes about a million years for energy created in nuclear reactions near the centre of the sun to make its way to the surface and be radiated so that we can enjoy its warmth and put it to good use. It takes the neutrinos born in those nuclear reactions just 10 minutes to arrive here, so they should tell us what is happening at the centre of the Sun today, not a million years ago. That is one of the main

ANTIPARTICLES Elections $e^- v_c - e^+ \overline{v}_e$				TICLES	PAR	FAMILY
				S	ICLE	ANTIPART
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Muons $\mu \nu_{\mu} \mu' \nu_{\mu}$	u	$\overline{\nu}_{\mu}$	μ^+	$\nu_{\rm u}$	μ-	Muons

reasons why physicists have built large detectors underground. They are looking for solar neutrinos.

What solar neutrino experiments are telling us is just a little worrying, and very exciting. The first - pioneering experiment of Ray Davis, which has operated for over twenty years in the Homestake mine in South Dakota, measured less than a half of the expected flux of neutrinos. This is a heroic experiment. The tank contains 380,000 litres of dry cleaning fluid and is located in a deep mine. The solar neutrinos are expected to convert some of the chlorine atoms in the fluid into argon (this is the inverse of beta-decay) and the task of Davis and his team was to measure the number of argon atoms produced. They expected 1.3 atoms per day to be produced and they measured about 0.5 per day. Finding one atom of argon in a tank containing over 1031 atoms of chlorine makes finding a needle in a haystack, while blindfolded, seem like child's play. So it was not surprising that some doubted the Davis result. Could it be that he was only finding 1/3 of the neutrinos created in his tank? Then another experiment, in the Kamiokande mine in western Japan, which used a very different, more modern, technique confirmed the Davis result.

So, was the sun about to 'switch off'? Nobody thought so and you didn't hear physicists proclaiming that "the end is nigh". Both experiments were sensitive to neutrinos with relatively high energy produced in rare nuclear reactions, whereas the nuclear reactions producing most solar energy give lower energy neutrinos, which these experiments

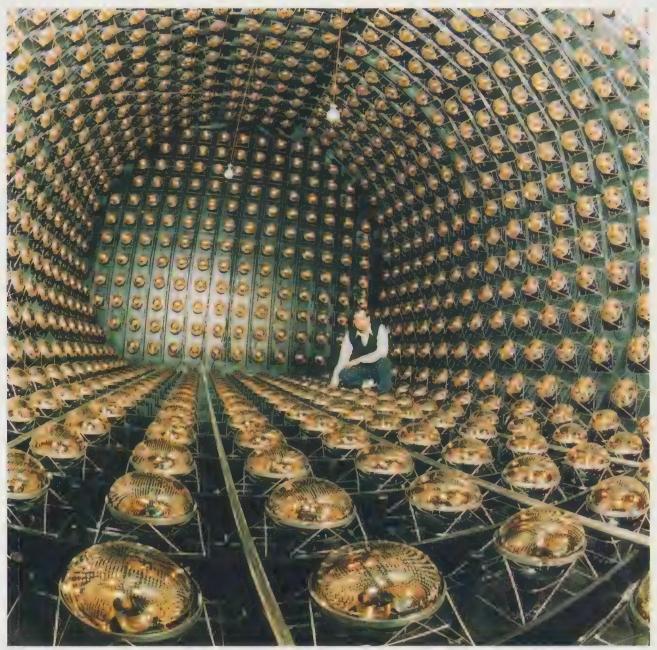
would not have recorded. So these pioneering experiments are unable to answer the important question: "What is the rate of energy production at the centre of the Sun today?"

Now that has changed. New experiments, sensitive to those crucial low energy neutrinos, have started to report. And they are also recording too few neutrinos, in this case about 2/3 of the expected number, so it is once again pertinent to ask if the sun is about to run down. Nobody is too alarmed as the nuclear reactions producing the bulk of solar energy, and hence the bulk of the associated neutrinos, are very well understood. But that makes the predictions of the resulting neutrino flux here on earth very reliable and raises again the question of why they are not detected.

A different hypothesis which would also explain the neutrino shortfall is that, between their creation near the centre of the sun and their arrival at the earth, the neutrinos themselves change. The neutrinos created in the sun are electron-neutrinos and, were some of them to change to muon-neutrinos or to tau-neutrinos on their journey to the earth, then they would not be observed in the detectors currently operating. At first such a spontaneous transmutation may seem a most unlikely scenario but, as we will see, many physicists are seriously attracted to it.

the phenomenon where a neutrino spontaneously changes into one from another family, say from electronneutrino to muon-neutrino. Apart from being a possible solution to the solar neutrino problem, the hypothesis is attractive for at least two other reasons.

• As discussed above, the basic building blocks of the universe are quarks and leptons, and the analogy between quarks and leptons is strong. There are six quarks, plus their 'antis', and they fit nicely into three families just like the leptons. Many theories play on this



A recently completed neutrino detector at the Los Alamos laboratory. The large hemispherical objects are photomultipliers. (The photomultipliers in the Kamiokande experiment are 2.5 times larger than these.)

resemblance and some rely on it. Oscillations between the various families of quarks *do occur* and have been studied for thirty years. So, if the quarks can oscillate, it is plausible that the leptons can 'do it' too.

• Oscillations between the various types of neutrinos can occur only if they have a mass and, as we saw above, there is no compelling reason to forbid neutrinos from being massive. Indeed if one or more species of neutrinos were found to be massive, it could solve an outstanding problem in cosmology.

Searches for neutrino oscillations use neutrinos from three sources: nuclear reactors, high energy accelerators and cosmic ray interactions in the atmosphere or in the earth. To date, all searches have been negative, and have served only to set limits on neutrino masses and the rate of change. The interest in searching further is intense and, as a consequence, new experiments are planned. CERN has approved two new large experiments which will collect data in 1994 and 1995. CERN's competitor in the USA, Fermilab near Chicago, proposes to mount another experiment but not until 1998.

The new CERN experiments are called NOMAD and CHORUS. (All experiments need a good acronym and

they are often rather contrived: NOMAD is derived from Neutrino Oscillations in MAgnetic Detector, CHORUS from Cern Hybrid Oscillation Research apparatUS!) The two experiments use different techniques and complement each other well. As physicists from Australia (from Universities of Melbourne and Sydney and from ANSTO, the Australian Nuclear Science and Technology Organisation) are involved in NOMAD, I hope that we see oscillations first, but our 'friendly rivals'

CHORUS have just as good a chance. Both experiments have the advantage that the chance of a neutrino interacting doubles each time that its energy doubles. The very high energy neutrinos that we can create at CERN are much more likely to interact with a given mass than solar neutrinos would be. That helps but a very massive detector is still needed. The photograph shows one of the experiments that occupied, for most of the 1980s, the area where NOMAD and CHORUS are being constructed. For two years both experiments will be running almost round the clock, 24 hours a day, 7 days a week. In that period we estimate that 1017 neutrinos (i.e. 100,000,000,000,000,000), mostly muon-neutrinos, will pass through each experiment but a mere one million will reveal their passage by interacting.

The hope is that a few billion neutrinos will have changed from muon-neutrino to tau-neutrino in the one kilometre between their creation and the experiments, and that a few of those tau-neutrino will interact with our detectors. Should that occur, our task is to recognise those one or two tau-neutrino interactions among the million



The CHARM II experiment, which was named after the original collaborating institutes: CERN, Hamburg, Amsterdam, Rome and Moscow.

muon-neutrino interactions. We may not find oscillations, in which case about 400 man-years of effort will have been spent in producing more stringent limits on masses and oscillation rates than exist today. All the easy experiments have been done and you have to be an optimist to do physics, especially neutrino physics!

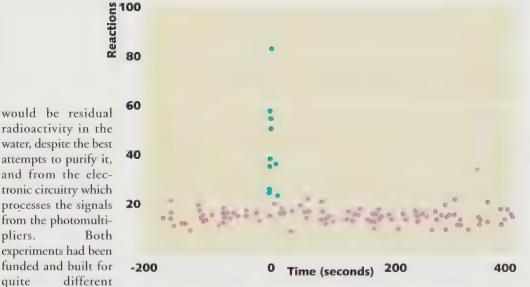
OW LET US CONSIDER SUPERnova SN1987A. About 170,000 years ago a star died in a neighbouring galaxy, the Large Magellanic Cloud. It had lived for to million years but its core collapsed under gravity in less than a second.

In the following ten seconds the star radiated about 1040 mega-joules(MJ) of energy. That is 10 followed by rather many zeros, so let's compare it to other amounts of energy. When you eat an average sized doughnut your body acquires 1MJ of chemical energy. I, like many other Melbourne householders, use about 500MJ each day in winter to keep my house warm. More relevant is to make a comparison with other astronomical sources of energy. In those ten seconds the dying star radiated a

hundred times more energy than our Sun will do in its expected lifetime of to billion years. The result of the death of that previously inconspicuous star was a supernova, the first visible on Earth to the naked eye since the time of Galileo.

We know now that neutrinos play a key role in causing supernovae to occur and that most (99%) of the dying star's energy is released as a burst of neutrinos. Neutrinos travel at the speed of light, or 'all but' if they have a small mass. Several days passed before the supernova was bright enough to

be seen, even by telescopes. But, as those billions of neutrinos swept through the earth, about ten were observed by physicists operating two large detectors, one deep underground in Japan, the other in the USA. The figure shows the count rate in the Japanese detector with a sharp increase at 'time zero', which was actually at about 10:35 pm in Japan on that fateful day in February 1987. In that experiment neutrinos eject electrons from atoms in the very clear water which fills their tank. Those electrons, which are travelling faster than the speed of light in water (which is almost exactly three quarters of the speed of light in a vacuum), then produce photons of blue light via the Cerenkov effect. (Named after its Russian discoverer, this same effect produces the blue glow often used to depict nuclear reactors in second rate films.) Finally those photons are detected by photomultipliers, which convert them into a small electric current that can be amplified and recorded. The figure also shows the ever present spurious signals that physicists term 'noise'. These arise from a variety of sources - no experiment is perfect. In this case the major sources of noise



The death of a star: photomultipliers in the Kamiokande detector record a burst of neutrinos from Supernova SN1987A, a star which died in a neighboring galaxy about 170,000 years ago. In ten seconds the collapsing star radiated 100 times more energy than our Sun will do in 10 billion years. 99% of the dying star's energy was radiated as neutrinos and as the billions of neutrinos swept through the earth, in February 1987, about 10 were counted by two detectors. The figure above shows the count rate in the Japanese detector at 'time zero', which was actually about 10.35pm. The dots in the main band are 'noise'.

Only six supernovae have been seen in our galaxy in the last 1000 years, all relatively close by.

purposes (such is the

serendipity of science,

sometimes) and in

that instant a new

science was born,

neutrino astronomy.

pliers.

quite

Observations of other galaxies indicate that supernovae occur much more often, three or four bangs a century is more typical for galaxies similar in structure to our galaxy. So why haven't we seen them? Supernovae are most likely to occur close to galactic centres and the line of sight from the centre of our galaxy to earth is obscured by dust, preventing visible light from reaching here. Suddenly the great penetrating power of neutrinos is an advantage! They will penetrate the dust with ease and, because the centre of our galaxy is much closer than the Large Magellanic Cloud, the flux of neutrinos will be far higher than that detected in 1987. The odds are that the next supernova will be seen by ten detectors not just two, and that each will record many hundreds of neutrinos not a handful. By timing the arrival of the neutrino pulses they will be able to find the point in the sky where the supernova occurred.

What is the role of neutrinos in cosmology? The stars which form 'our' galaxy are clearly visible on a good night. We see not only thousands of nearby, individual stars, but also the Milky Way,

a great cloud of more distant stars in the galaxy. (I would like to think that other scientists, on other planets orbiting other stars, think of it as 'their' galaxy, but the search for extra-terrestrial intelligence is another story). Thanks to observations with telescopes we know our galaxy is but one among billions.

Until quite recently there was widespread belief that most matter in the universe was to be found in those galaxies of stars, so called 'hot' matter because it radiated light. Several observations have changed that view and suggest that hot matter accounts at most for 10% of the mass in the universe.

- Stars in galaxies do not rotate about their centres in the manner that Newton's Law of Gravitation would require. This suggests that galaxies contain significant amounts of nonluminous matter.
- Studies of the universe on a larger scale, in particular the relative motion of galaxies, again indicate a need for nonluminous matter.
- The only reasonable theory which explains how the universe evolved from the Big Bang to its present state becomes

untenable if only 'hot' matter is considered. That is a real problem because the scientific evidence that it did start with a Big Bang is overwhelming.

The observations above suggest that as much as 95% of the matter in the universe is 'dark', i.e. non luminous. And massive neutrinos are the most credible candidate for this dark matter. Existing experiments can only set upper limits on the masses of neutrinos. The mass values that neutrinos would need to have if they are indeed the

required dark matter are way below those limits, but they are accessible (just) to experiments such as NOMAD and its rivals.

Where did all those neutrinos which fill the universe come from? They have always been there, or almost always. They are a relic from the Big Bang, and have been cruising the universe ever since, perturbing the rotations of galaxies and awaiting physicists clever enough to devise an experiment to detect them directly. But, as we will see, they may have to wait a while yet.

HE TRAIL TO INTERCEPTING these relic neutrinos started nearly 30 years ago. In 1965 two engineers working on satellite communications at Bell Laboratories in the USA made, again serendipitously, what is perhaps the most important astrophysical observation of the century. They discovered the 'cosmic microwave background radiation', the most compelling evidence for the Big Bang.

At first the universe was very opaque to light. Particles of light (photons) were energetic enough to ionise hydrogen "It takes about a million years for energy created in nuclear reactions near the centre of the sun to make its way to the surface and be radiated so that we can enjoy its warmth and put it to good use. It takes the neutrinos born in those nuclear reactions just 10 minutes to arrive here."

atoms and there was an abundance of such atoms waiting to absorb them. Then, after about 100,000 of our (present) earth years, the photon energies had decreased to a level such that they could no longer ionise hydrogen and the universe suddenly became transparent. Incidently if God really did cause the Big Bang, as some scientists do believe, it must surely have been then that He said "Let there be Light". The photons existing at that time have been travelling unhindered through the universe ever since awaiting discovery by someone who could understand their significance. They had to wait until 1965, at least on this planet.

As we have already seen, neutrinos interact only very weakly with matter and, just one second after the Big Bang, the universe became 'transparent' to neutrinos and they were able to range freely through it. The neutrinos existing then are today's relic neutrinos, which may be the required cold dark matter. Unfortunately their feeble energy makes them extremely hard to detect. Now the chance of their interacting with a given amount matter are much, much less than even for solar neutrinos. Suffice it to say here that many of the most able experimental physicists have spent decades trying to design experiments to detect them, and nobody has produced an idea with even a ghost of a chance. In some ways, it is nice to know that some fundamental experiments will be left for my daughter, or grandson, to do!

E NEED NEW DETECtors. We need more
facts. In science one
uses data to test theories
and it is evident that we need more
information to unravel these puzzles.
New underground neutrino detectors
are being commissioned, built or
designed. There are now four actively
collecting data, four more due to start
between 1996 and 1998, and at least
another three seriously proposed. And

even grander schemes are afoot. Given the scope, and cost, involved these are invariably worldwide collaborative efforts.

- Since 1973 scientists have been evaluating the feasibility of a large neutrino detector in which ocean water is the 'target' in which the neutrinos interact. A prototype detector is now operating in the clear waters off the island of Hawaii.
- Another recent idea is to use the clear Antarctic ice as a target.
- The ideal neutrino detector might be located on the Moon. The reason that current detectors have to be placed deep underground is to avoid problems caused by the interactions of cosmic rays in the atmosphere. On the moon, which lacks an atmosphere, they could be buried a few metres below the surface. However there could be other novel problems with a moon-based detector.
- Proposals exist to shoot the beams of high energy neutrinos from accelerators such as at CERN and Fermilab through the Earth towards existing solar neutrino detectors in Japan and elsewhere.

HY STUDY NEUTRINOS? I would hope that any reader who has reached this point will understand why scientists like myself want to study neutrinos. We are fascinated by this little particle, postulated sixty years ago to save the Theory of Conservation of Energy in beta-decay. Since Pauli's postulate the neutrino has:

- helped us unravel many problems in particle physics,
- given us a way of 'looking' at the centre of the Sun,
- founded a new science (Neutrino Astronomy) which should soon enable us to see supernovae at the heart of our galaxy.

Add to that list the possibility that neutrinos may even be the dominant form of matter in the universe, and yet we know so little about them, and the reasons for building more, and better, neutrino detectors should be evident. However, whatever the results of the new experiments discussed above, I predict that neutrinos will continue to fascinate us for another sixty years, if not longer.

It must be clear, from the photographs of neutrino experiments and from the need to mount worldwide collaborative efforts to fund them, that this is *not* a cheap branch of science. A pertinent question is then: "Why do governments fund what is undeniably a very expensive branch of science?"

Neutrino experiments, as with most experiments in high energy particle physics, are in general not funded solely due to the altruism of the governments concerned, although I would like to believe that this is a factor. One reason for supporting this type of work is that provides superb training for the best experimentally inclined graduate students. Indeed, many of the best science and engineering students entering university have been attracted to their subjects by reading about fundamental research activities in journals such as Scientific American. Whether they eventually work in government or industrial research and development, or (in a minority of cases) participate in basic research themselves, their initial motivation is often front-line basic science. Principally however this research is funded for the stimulus it provides to industries to work at, or often to extend, technological frontiers.

Further Reading

Spaceship Neutrino, (Cambridge University Press, \$29.95), a new book by Christine Sutton, a frequent contributor to the New Scientist, presents a very readable account of what is surely the most mysterious particle that nature has invented. There are no mathematics or formulae, and the book is copiously illustrated with diagrams and with photographs, many with historical interest.



SCALING THE ARCHITECTURE

The Scalable Array Processor (SCAP) is an Australian-designed, next-generation computer architecture which is promising to turn desktop computers into near-supercomputers. Developed by the author and Defence Department colleagues in South Australia to speed up the heavy computing demands of signal processing, SCAP combines extremely high-speed numbercrunching with the ease of programming of personal computers. In recent tests the performance of a desktop workstation was improved by a factor of 200. Immediate applications appear likely in fields as far apart as oil exploration, medical imaging and virtual reality.

HE SCAP DEVELOPMENT STARTED in late 1982 when two researchers at the Defence Science and Technology Organisation (DSTO), Pat Clarke and the author, began to consider how new integrated circuit technology could be used to speed up the processing of signals received by sonar detectors on ships, submarines and helicopters.

Very Large Scale Integration (VLSI) design techniques were being introduced to Australian researchers and industry by the CSIRO's VLSI program, headed by Dr. Craig Mudge, now professor of computing science at Flinders

University. Since that time, VLSI techniques and technology improvements have made possible the dramatic increases in computing power which has occurred in the last decade. However, the concepts embodied in today's computer

processors do significantly differ from

not

those found in the processors of a decade ago. Also, the use of multi-processors that is, several processors linked together to work on a single numerical task - is still in its infancy in most computers.

A new concept introduced in 1978 by H T Kung of Carnegie-Mellon University was just being explored at this time and was a prime candidate for implementation in VLSI. The tech nique, which was referred to as 'systolic',

"Data moves through the array not unlike the way blood is pumped through the body by the heart."

> requires large arrays of processing elements, or small computers, each connected to its nearest neighbor in a regular manner such as in a two-dimen sional mesh. Data moves through the

array and is operated upon in a rhythmic manner not unlike the way blood is pumped through the body by the heart.

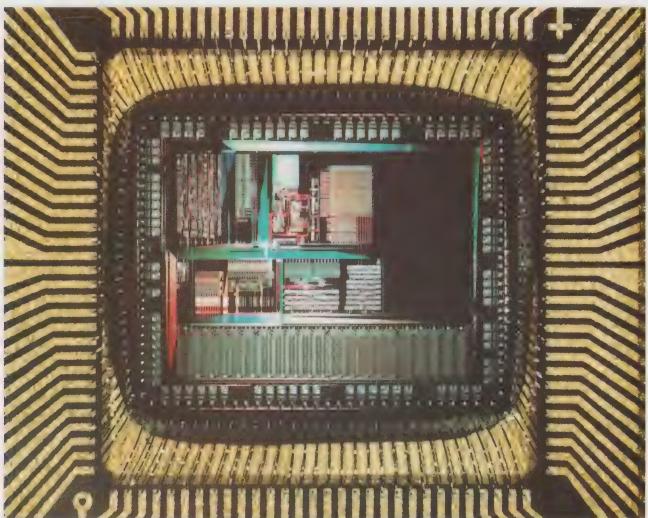
Systolic processor research was characterised by several aspects. One was the extremely large number of processors required to solve real-world problems. Another was the proliferation of research articles on the theory of these processors, with a remarkable lack of reporting of any that had actually been built. Another and most important aspect was the preoccupation of most researchers with finding an optimum systolic array to solve a particular task. In

addition, few researchers showed interest in considering how large tasks could be handled with small systolic arrays.

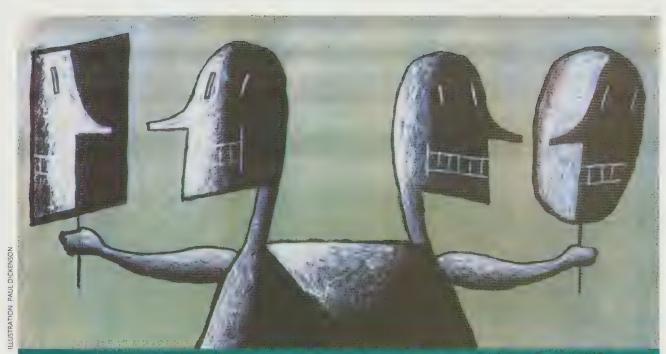
The lack of working systolic processors was largely a consequence of systolic techniques providing designers with as many dilemmas as solutions. It was possible to show that extremely high speed processing was achievable, but it was also apparent the type of processing that could be done with a particular systolic array was very restricted. The regular architectural structure of the processors provided benefits by offering a technique to control design complexity in large systems, but again any one architecture had very restricted application, so preventing the construction of systems. In short, they provided the lure of elegant technical solutions to problems which were too restricted to justify the cost of solution.

This is the environment in which research began on what has now become

We adopted a pragmatic approach which did not seek to define the "ultimate" systolic processor architecture capable of implementing any desired computer program. The idea which was



Fastest single-package computer module on Earth: a 400Mflops multi-chip SCAP module, measuring 7.5 cms square.



"Within one or two years, workstations and personal computers with design speeds of between 5 and 50 Mflops, may be enhanced by SCAP coprocessors into process numbers at rates which lie in the range 3000 to 10,000 Mflops."

pursued was to design a systolic processor that would efficiently implement the operations of matrix algebra. The reasoning behind this approach was simple:

- Most of the signal processing techniques required could be written simply in terms of the mathematics of matrix algebra. In fact, Ravi Iyer at the University of Illinois recently estimated that 80% of the problems solved on supercomputers were done by multiplying matrice.
- Most of the known operations of matrix algebra could be implemented with a very restricted set of 'primitive' matrix operators. This set was defined by the operations of addition, subtraction, elementwise multiplication, matrix multiplication and transposition (see box over page).

The operation of matrix multiplication is extremely time-consuming on a conventional computer, as each matrix must be read from memory many times in order to compute the result. For example, the multiplication of two 20x20 matrices would require the processor to fetch each matrix from memory 20 times in order to make the single calculation.

In contrast, a SCAP processor would fetch each matrix from memory just once. The SCAP concept relies simply on the ability of programmers to write well-known matrix expressions, whereas many of today's processors require highly sophisticated users who need to understand the nuances of computer architecture in order to write efficient software.

of SCAP showed that the design and construction of a systolic array was well suited to VLSI techniques and could be done in a comparatively straightforward manner. However, it became apparent such arrays would be of limited value if only

the simple matrix structures common in text books were able to be processed. Many algorithms which were of major interest to signal processing were not commonly expressed in matrix form.

A particular example was the Fourier transform, an algorithm used to convert time-varying signals to representations in terms of fixed frequency components, or tones. An example of the application of the Fourier transform could be to transform the signal from a microphone, which can be a set of values representing the sound intensity sampled at a regular time intervals, to a different set of values which represent the signal in terms of the tones present in the signal. The algorithm can be used to 'compress' the signal for applications such as High Definition Television (HDTV).

The Fourier transform forms the basis of many signal processing tasks, but is rarely expressed in matrix form, even in the scientific literature. However, after some research, it became

Working with matrices

A matrix can be regarded as a kind of generalised number. Each matrix comprises a two-dimensional set of elements, usually numbers, arranged in rows and columns in much the same way as the numbers on a bingo card. Adding two matrices, A and B, is similar to ordinary algebra

If matrix	A =		1
		3 . 4	
and matrix	B =	8 6	1
		7 2	l

then for the elementwise operations of addition, subtraction, and elementwise multiplication the matrix result of the required operation is simply the result of applying the operation to the corresponding elements of each matrix.

		401404
A + B =	9	8
	10	6
		1
A ● B =	8	12
	21	8
	A + B = A ● B =	A ● B = 8

where • means an elementwise multiplication.

In the case of transposition, a matrix is 'reflected' about its main diagonal. For example, the transpose of A is

I 3 2 4

The definition of matrix multiplication is quite different to the elementwise operations. Each element of the resulting matrix requires a complete row of A to be processed with a complete column of B. The procedure is to multiply corresponding elements of a selected row and column, and to add all of the resulting products, Hence

apparent the algorithm – originally considered inappropriate for a matrix processor - could be processed even faster with matrix techniques than with conventional methods such as vector processing.

To do this required an extension to the SCAP concept so that matrices could

be 'restructured' as they were read from memory and fed into the systolic matrix engine. The extension required the invention and patenting of a new component for the system, a data controller chip, to be built using VLSI techniques.

Associated with the design of the

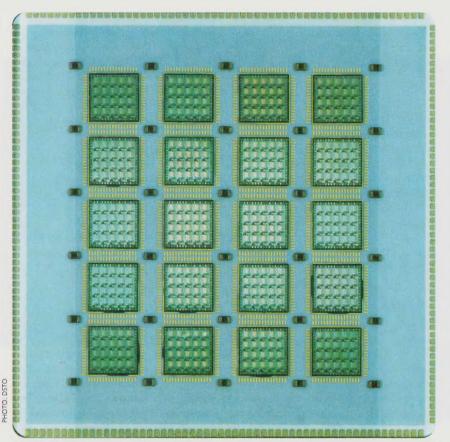
chip was a technique for the specification of a matrix in terms of a simple 'matrix descriptor' or set of values that describe the size of a matrix and other information used to change the way the matrix could be accessed. The descriptor allows any size matrix to be defined in terms of about 10 numbers. The writing of the matrix descriptor to the data controller chip allowed the data controller to take over the role of fetching data from memory and entering it into the array.

The data controller uses difference engine techniques in which results are computed by the repeated addition of one or more constant numbers to some initial number. The benefit of the approach is that it only requires an adder, not a multiplier, and in general, requires much less silicon area, and is faster.

The results of this research were considered by a number of consultants, and on their recommendations a contract was let by the Defence Industry Development Office to Austek Microsystems to design a concept demonstrator for SCAP. The concept demonstrator was to be constructed from two custom VLSI chip types – a data controller and a systolic array chip. In each SCAP system, three data controllers were to be used, and sufficient systolic array chips were to be interconnected to create a 20 by 20 systolic array of processing elements.

The contract was re-let to a sub-contractor, RADLogic Pty. Ltd., a South Australian firm, which completed and supplied five prototype systems to the DSTO in November 1992 for evaluation. RADLogic is probably the first company in the world to successfully design and construct a two-dimensional systolic array using VLSI technology. The design was carried out using proprietary tools written by Austek Microsystems, and was fabricated by Hewlett-Packard of the United States.

The results of the development were dramatically successful. The concept



SCAP's data controller: efficiently describes a matrix of any size.

demonstrator was placed in a Sun Microsystems workstation in 1992, and during development achieved in excess of 200 million floating point operations per second (Mflops) when executing a realistic signal processing program such as filtering. Filtering in this sense can mean a process which is used to remove unwanted noise, or spurious signals from a desired signal. An everyday example of a filter is the tunable part of a radio or television receiver, which selects the station of interest from all the signals which are being simultaneously received at its antenna.

The speed of the simple SCAP processor approaches the speed of supercomputers such as the CRAY. To understand the significance of this performance, the peak speed of the workstation without SCAP is only about 1.7 Mflops, and when executing typical

programs, the actual speed drops to less than 1 Mflops. The SCAP concept had packed the performance of 200 workstations into one workstation. Currently, reliability issues limit the peak performance to about 120 Mflops, a figure which is still 100 times faster than the host workstation.

HE DEVELOPMENT HAS NOT stopped. The first concept demonstrator systems produced by RADLogic were implemented with conventional integrated circuit packaging techniques on a standard printed circuit board whose size was about 22cm by 22cm.

Late in 1992, a new technology was used to shrink the systolic array to a multi-chip module measuring 7.5cm by 7.5cm. These modules appear to be the fastest single package computer modules

in the world today, offering peak computation rates of 400 Mflops. (By comparison, the author's 80486 66MHz personal computer peaks at about 9Mflops, and evaluates matrix computations at between 1 and 10Mflops).

Constructed jointly by the DSTO and Philips, and using the same VLSI chips as in the concept demonstrator, the modules are being used in new architectures for both Sun workstations and the IBM/PC. These new architectures use surface mount technology to increase the density of components on the boards. These new boards can 'turbo-charge' even the humble desktop word processor so that it can challenge the performance of multi-million dollar supercomputers.

The cost of SCAP-based systems is about \$20,000 in small numbers. This is a figure which would fall significantly in large production quantities.

At the University of Adelaide, studies are being conducted into the use of gallium arsenide instead of silicon in systolic processors. These studies show that the next generation of systolic processors will be at least 10 times faster than the processors of today. This means that within one or two years, workstations and personal computers with design speeds of between 5 and 50 Mflops, may be enhanced by SCAP coprocessors to provide users with the capability to process numbers at rates which lie in the range 3000 to 10,000 Mflops.

The current SCAP, invented by DSTO scientists and implemented by Australian industry, has been developed with the financial and management expertise of the Defence Industry Development Office. Patents protect the intellectual property embodied in the SCAP concept. Apart from military applications, SCAP has potential application in many areas, including seismic processing in the oil industry, modelling of weather, medical tomography, and a range of consumer electronic uses such as virtual reality.

GREENING THE GAMES: Peter Droege is Chair of Urban Design, Faculty of Architecture, University of Sydney. He has served as an urban design advisor to Australia's Multifunction Polis, and is the chief editor of a forthcoming journal on information technology, communications and urban change. THE CONTROVERSIAL MENOPAUSE: Lorraine Dennerstein is Director of the Key Centre for Women's Health in Society, Department of Public Health & Community Medicine, University of Melbourne. She has co-written several books, including Psychosocial and Mental Health Aspects of Women's Health and Psychosomatic Gynaecology: A Total Approach to Women's Health Problems.

SCIENCE IN AUSTRALIA'S MEDIA: Steve Utick is responsible for the Science and Technology Awareness Program (STAP) of the Department of Industry Technology and Regional Development (DITARD).

LOOK WHO'S TALKING: Kent Wildish is a Curator at the Powerhouse Museum in Sydney and is currently coordinating its *Telecom Lazerlink: at home in the future* exhibition. He is completing a PhD in biomedical engineering on ion beam modification of man-made substances.

CATCHING GENES IN THE SCREEN: Robyn Williams is a science writer and broadcaster, and Chairman of the Australian Commission for the Future. He produces and presents the ABC's Science Show and Ockham's Razor.

TOUGH CHOICES BEDEVIL SUSTAINABLE DEVELOPMENT: Sharon Beder is an engineer and a lecturer at the Science and Technology Studies Department, University of Wollongong. She is the author of *Toxic Fish and Sewer Surfing* and *The Nature of Sustainable Development*.

No ROOM IN THE ARK: Charles Birch is a population ecologist and Emeritus Professor of the University of Sydney. His books include *Confronting the Future, Regaining*

Compassion and The Ecological Web. He is a Fellow of the Australian Academy of Science and a member of the Club of Rome.

THE ECONOMICS OF GLOBAL WARMING: Sally Thorpe is a principal research officer for the Australian Bureau of Agricultural and Resource Economics in Canberra. The late Edward Wheeler was a senior editor at ABARE. Brian Fisher is the Bureau's Executive Director.

BANKING ON THE ENVIRONMENT: Christopher Davey, a former mining engineer, is Manager, Project Finance, National Australia Bank, Chairman of the Australian Bankers' Association Environmental Taskforce, and a member of the environment committee of the Business Council of Australia.

SHATTERED SHORELINES: Peter Craig is an oceanographer and a research scientist at the CSIRO Division of Oceanography in Hobart. His research field is mathematical modelling of ocean currents in near-shore waters.

ENVIRONMENTAL BOOK-KEEPING REVEALS CONFLICTING ACCOUNTS: Bryan Jenkins is an engineer and Director of Environment, Economics and Planning, Kinhill Engineers. He has been responsible for environmental studies throughout Australia, including the study into the proposed third runway at Sydney Airport. He is Chairman of the National Committee on Environmental Engineering, Institition of Engineers Australia. WATER'S VITAL PROFILE: Graham Allison is a hydrologist and Foundation Chief of the CSIRO Division of Water Resources. He is a member of the boards of the Co-operative Research Centres for Catchment Hydrology and Waste Management and Pollution Control.

THE FACTS ON PHOSPHORUS: Peter Cullen is director of the Cooperative Research Centre for Freshwater Ecology, based at the Australian National University.

BIODIVERSITY IN THE BALANCE: Harry Recher is an associate professor in the Department of Ecosystem Management at the University of New England. His research includes the effects of fire and logging on forest wildlife and the impact of vegetation clearing on woodland insects and birds.

ABORTING THE SLAUGHTER: Ann Maree Nobelius is a postgraduate research student in reproductive science at the Department of Physiology, Monash University.

MANAGING LAND AT THE GRASS ROOTS: Brian Scarsbrick is the Chief Executive of Landcare Australia. He is a recipient of a Churchill Fellowship awarded for the study of sustainable land management and sponsorship marketing in Europe and the United States.

LOST BETWEEN ERAS: Rick Slaughter is a futurist, author and academic. He is currently Lecturer in Futures and Social Education at the Institute of Education, University of Melbourne.

THE FUTURE OF RELATIONSHIPS: Merran White is a journalist, researcher and author specialising in social issues and currently working with Australian Consolidated Press. Her books include Going Solo: A Guide for Women Travelling Alone and Lover's Guide. THE GHOSTLY NEUTRINO: Stuart Tovey is a physicist and Reader in Experimental Particle Physics at the Research Centre for High Energy Physics, University of Melbourne. He is currently involved in an experiment at the European Laboratory for Particle Physics (CERN), near Geneva, which is searching for neutrino oscillations.

SCALING THE ARCHITECTURE: Warren Marwood is a computer scientist and a senior researcher at the Materials Research Laboratory, Defence Science and Technology Organisation in Salisbury, South Australia. He is the co-developer of Scalable Array Processor (SCAP).

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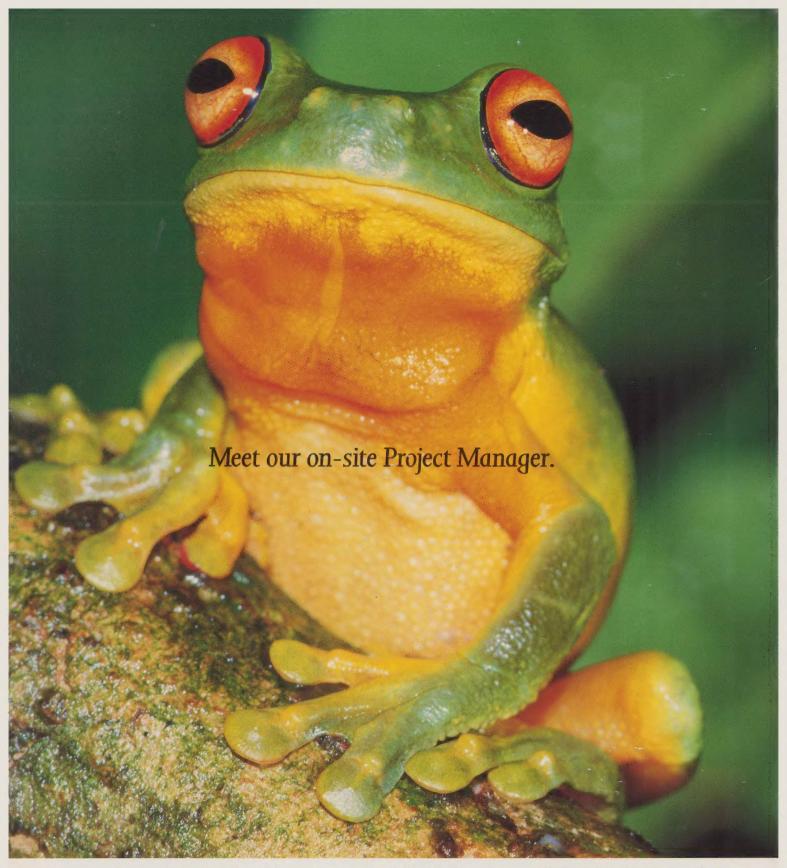




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